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OPERATION MANUAL

SPECTRUM ANALYZER

MS611A

ANRITSU CORP.

1985.10 x 80 NIII-7(Y)
Printed in Japan

CERTIFICATION

Anritsu Electric Co., Ltd. certifies that this instrument has been thoroughly tested and inspected, and found to meet published specifications prior to shipping.
Anritsu further certifies that its calibration measurements are based on the Japanese Electrotechnical Laboratory and Radio Research Laboratory standards.

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Anritsu changed its name from Anritsu Electric Co., Ltd. to ANRITSU CORP.

The new name is effective from October 1st 1985. Please change the old name to the new name in this manual.

MS611A SPECTRUM ANALYZER

MANUAL CHANGE

This supplement contains six informations for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

1. Section 3.9.2 Arithmetic Function

(1) A-B→A

- Page 3-56, line 5 to 7:

Change "The reference value ..... Δ DISPLAY LINE" to "The reference value of the subtraction results changes depending on the DISPLAY LINE, or depending on the active line of Δ DISPLAY LINE."

2. Section 3.10.6 PEAK SEARCH functions

(2) NEXT PEAK

- Page 3-73, line 8:

Change "This movement can be repeated up to ten times" to "This movement can be repeated up to nine times."

3. Section 3.11.4 INPUT ATTENUATOR

Page 3-90, line 4, 5:

Change "In AUTO COUPLED mode, ... RESOLUTION BW", to "In AUTO COUPLED mode, the preset value of the INPUT ATTENUATION is set according to the REFERENCE LEVEL, RESOLUTION BW and VIDEO BW."

Page 3-11 and page 3-13:

Accordingly, change the initial value of input attenuator to 5 dB. ("AT 10 dB" → "AT 5 dB" at the initial state shown in Fig. 3-5, and at the FULL SPAN shown in Fig. 3-7.)

4. Section 3.13.3 DIGITAL VIDEO AVERAGING

o Page 3-101, line 9 to 11:

Change "When a sweep repetition count ..... at the count" to "When a sweep repetition count is previously input, the averaging is performed up to averaging times. On additional sweeps after the times, the current data are added at the rate depending on the preset repetition times."

o Page 3-102, line 16 to 28:

Change "(3) The averaging count ..... cannot be input" to "(3) The averaging count can be changed by pressing the SHIFT and VIDEO BW keys, by inputting a numeric value (2 to 1000), and by pressing one of unit keys in this order. After pressing the unit key, AVERAGING starts from the beginning.

For example, AVERAGING with 50 times can be executed by pressing the SHIFT, VIDEO BW, 5, 0, GHz keys in this order."

o Page 3-103, line 9 to 18:

Change "(5) During AVERAGING, a set value .....,
(6) When AVERAGING is ..... VIDEO BW keys" to

"(5) On during AVERAGING, changing the set parameter such as CENTER FREQUENCY or REFERENCE LEVEL, AVERAGING restarts from the beginning again.

(6) During AVERAGING, the sweep stops by pressing the DISPLAY mode VIEW, and also AVERAGING stops. Another AVERAGING can restart from the beginning by pressing the CLEAR/WRITE, SHIFT, and VIDEO BW keys in this order."

5. Section 4.5 Setting Front Panel Functions

o Page 4-7, line 29 to 31:

Change "The MS611A reads ..... the program data format" to "The MS611A reads the program data from the controller until the line feed code is detected, and checks the program data format. (One program data must be within 1024 characters including the line feed code.)"

6. Section 4.6.3 Reading Spectrum Data

Page 4-25 as Table 4-18:

Change Table 4-18 to following new one:

Table 4-18 List of U3-Mode Unit

SCALE	REF, LEVEL unit	Output unit	Remarks
LOG	dBm	dBm	
LOG	dBμ	dBμ	
LOG	V, mV, μV	dBm	
LIN	V, mV, μV	——	Not supported in mode 03

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SECTION 1

GENERAL

The MS611A is a high-performance, general-purpose spectrum analyzer which covers 50 Hz to 2 GHz with one band. The MS611A is used to measure the frequency and level of various signals such as voice frequency band signals, VHF signals and UHF signals. Especially, the MS611A is used to develop and reserch, maintain various radio equipment and to monitor radio waves.

Since the MS611A can be controlled remotely by GP-IB, it can be incorporated into an automatic measuring system.

MS611A measures the following:

- Frequencies
  The frequency can be measured, even if faint signals.
- Spurious, undesired radiational signals
- Modulated waves
  AM waves, pulse waves, and TV waves can be analyzed.
- Occupied bandwidth
  The "X dB" method is used.
- Field strength
  Also a dipole antenna for measurement is used for this measurement.
- Harmonic distortion, intermodulation distortion
  Also signal generators are need for this measurement.

MS611A

SECTION 2

COMPOSITION AND SPECIFICATIONS

2.1 Composition

Table 2-1 shows the composition of this equipment.

Table 2-1 Standard Composition

	Name	Q'ty	Remarks
Instrument	MS611A Spectrum analyzer	1	
Accessories	Coaxial cords:	1	S-5DWP — 5D-2W•S — S-5DWP, 1 m
		1	BNC-P — RG-55/U — N-P, 1 m
	Power cord	1	With adapter
	Fuses	1 set	
	Operation manual	1	

2.2 Specifications

Table 2-2 Specifications

Frequency	Measuring frequency range		50 Hz to 2 GHz	
	Readout mode		Center Span, Start-Stop or Start Span	
	Center frequency		Setting range	0 to 2.099 999 999 GHz (maximum resolution: 1 Hz)
			Readout resolution	0.1% of frequency span (≧1 Hz)
			Readout accuracy	±{(Tuning frequency) x (reference frequency error) + (1.5% of frequency span) + 1/2 x (resolution bandwidth)}
			Setting	Number/units keys, step keys, data knob, "MKR → CF" key, SIGNAL TRACK key, or ZOOM key.
	Start frequency/stop frequency		Setting range	Same as that of the center frequency
			Readout resolution	Same as that of the center frequency
			Readout accuracy	Same as that of the center frequency
			Setting	Number/units keys, step keys, data knob, or Δ → SPAN key, when (Stop frequency - start frequency) ≧100 Hz
	Frequency span		Setting range	100 Hz to 2.09 GHz for horizontal 10 division 3 digits, (100 to 999) variable or 0 Hz (fixed tuning).
			Readout accuracy	±{(2.5% of frequency difference between 2 points) + (0.5% of frequency span)}
			Setting	Number/units keys, step keys, data knob, or Δ → SPAN key
	Marker	NORMAL	Function	Display the frequency of a tunable marker point. The resolution is 0.1% of the frequency.
			Readout accuracy	(Center frequency accuracy) + (Frequency span accuracy between center and marker)
		Δ(delta)	Function	Displays the frequency difference between two marker points. The resolution is 0.1% of the frequency span.
			Readout accuracy	Same as that of the frequency span
		COUNT	Function	Displays the frequency of a signal received at the marker point. The resolution is 1 Hz.
			Accuracy	(Readout frequency) x (reference frequency error) ±2 counts. Note: The level at the marker position must be at least 20 dB higher than the noise level or the level of the interference from adjacent signals. Also, the resolution bandwidth must be at least 5% of the frequency span.
		MKR → CF Δ → SPAN	Sets the center frequency equal to the marker frequency, or sets the start and stop frequencies equal to the frequencies of two marker points (delta marker).	
		SIGNAL TRACK	Sets the center frequency to place a peak signal on the screen at the center of the screen, and follow the peak signal.	
		ZOOM	Makes it possible to change frequency span about the tunable marker using step keys or number/units keys.	
	Reference Oscillator	Frequency	10 MHz	
		Stability	Warmup	≦ 1 x 10^{-7}/day after 30 minutes warm-up ≦ 5 x 10^{-8}/day after 60 minutes warm-up
			Aging	≦ 2 x 10^{-8}/day after 24 hours warm-up
			Temperature characteristics	Within ±5 x 10^{-8} at 25°C ±25°C of crystal oscillator ambient temperature
		External reference input	10 MHz, TTL	

Table 2-2 Specifications (Cont'd)

Frequency	Resolution	Resolution bandwidth (6 dB bandwidth)			10 Hz to 3 MHz variable, 1-3-10 sequence. Automatic setting according to the frequency span or manual setting.
		Selectivity (60 dB/6 dB)			<10 : 1 (3 MHz to 100 kHz) < 7 : 1 (30 kHz to 10 Hz)
	Residual FM				⩽ 2 Hz p-p/0.1 s (frequency span ⩽10 kHz)
	Drift				⩽50 Hz p-p/min. (frequency span ⩽10 kHz, at constant ambient temperature after one hour warm-up)
	Noise sidebands				⩽-80 dBc (At 2 kHz away from the signal, resolution bandwidth 100 Hz, video bandwidth 3 Hz, and frequency 1 GHz or less.)
Amplitude	Measurement range				+25 dBm to -135 dBm (average noise level)
	CRT Display	Graticule			Vertical 10 division (10 div). Thq top line of graticule on the CRT is the reference level.
		LOG	10 dB/div		+2.3 to -90 dB (resolution 0.1 dB) from the reference level
			5 dB/div		+1.15 to -50 dB (resolution 0.05 dB) from the reference level
			2 dB/div		+0.46 to -20 dB (resolution 0.02 dB) from the reference level
			1 dB/div		+0.23 to -10 dB (resolution 0.01 dB) from the reference level
		LIN			10% of reference level/div (calibrated in voltage)
		Linearity			LOG: ±0.2 dB/1 dB, ±1.5 dB/80 dB LIN: ±3% of reference level (full scale)
	Reference level	Setting range		LOG	+25 to -100 dBm or equivalent level in units of dBμ (e.m.f.) or volts
				LIN	3.976 V to 2.236 μV
				Readout resolution	0.1 dB or equivalent level
		Accuracy		Accuracy of calibrator output level	±0.3 dB
				Frequency response	±1.5 dB (50 Hz to 1.5 GHz) $^{+1.5}_{-3}$ dB (1.5 to 2 GHz)
				Reference level step error	After automatic calibration ±0.8 dB (0 to -50 dBm, input attenuator 10 dB) ±1.5 dB (+25 to -100 dBm, input attenuator variable)
				Resolution bandwidth switching accuracy	After automatic calibration, ±0.4 dB (at resolution bandwidth 3 MHz to 10 Hz). (The 100 kHz bandwidth is used as the reference bandwidth.)
				LOG scale switching accuracy	±0.5 dB
	Marker	NORMAL			Displays the level at the tunable mark point
		Δ(delta)			Displays the level difference between two marker points
		PEAK SEARCH			Sets the marker to a peak point on the screen.
		NEXT PEAK			Sets the marker to a next peak point.
		MKR → REF LVL			Sets reference level equal to the marker level.

Table 2-2 Specifications (Cont'd)

Amplitude (Cont'd)	Dynamic range	Average noise level	At input attenuator 0 dB and resolution bandwidth 10 Hz, -135 dBm maximum (at frequency 0.8 to 2000 MHz) -100 dBm maximum (at frequency 500 Hz to 800 kHz) -80 dBm maximum (at frequency 50 Hz to 500 Hz)
		Second-harmonic distortion	When the value obtained by subracting the attenuation value from the input level is -30 dBm, -80 dB maximum (at frequency 100 to 900 MHz) -70 dB maximum (at frequency 20 kHz to 100 MHz) -60 dB maximum (at frequency 50 Hz to 20 kHz)
		Two-signal third order inter-modulation distortion	When the value obtained by subracting the attenuation value from the input level is -25 dBm, -80 dB maximum (at frequency 20 to 1000 MHz, and frequency difference 2.5 MHz) -70 dB maximum (at frequency difference 1 kHz to 2.5 MHz)
		Residual response	At input attenuator 0 dB and 50 Ω terminated, -110 dBm maximum (at frequency 1 MHz or higher) -100 dBm maximum (at frequency 2 kHz to 1 MHz) -80 dBm maximum (at frequency 50 Hz to 2 kHz)
		Video bandwidth	1 Hz to 3 MHz, 1-3-10 sequence. Automatic setting according to the resolution bandwidth or manual setting.
		Input attenuator	0 to 55 dB, with 5 dB step. Automatic setting according to the reference level and resolution bandwidth, or manual setting.
	RF Input	Impedance	50 Ω VSWR ≦1.5 (input attenuator ≧10 dB), N-type connector
		Maximum input level	+25 dBm (input attenuator ≧15 dB), DC ±0 V
	Calibrator output level		-10 dBm ±0.3 dB (100 MHz)
CRT Display	CRT	Display area	100 mm x 125 mm
		Display item	Graticule, single traces, function data, and title
	Digital storage	Memory	Horizontal 1001 points x 10 bits, 2 channel (A and B)
		CLEAR/WRITE	Clears the memory when key is pushed, then writes and displays the signal response together with sweeping.
		MAX HOLD	Writes and displays the maximum response together with sweeping.
		VIEW	Displays the signal response which is stored.
		BLANK	Blank the signal response from CRT (the stored response is not lost.)
Arithmetic	A - B → A		Channel B amplitude is subtraced from A channel and the result is written into Channel A together with sweeping.
	A ⇄ B		Exchange channel A and B.
	B - DL → B		Display line amplitude is subtraced from channel B and the result is written into channel B which is set to VIEW mode.
Sweep	Sweep time		20 ms to 1000 s. Automatic setting according to the frequency span, resolution bandwidth and video bandwidth or manual setting. At frequency span 0 Hz, 10 μs to 1000 s can be set manually.
	Sweep modes		Continuous sweep and single sweep
	Trigger		Free turn, line, video and external trigger
Remote control			GPIB (IEEE488, IEC625-1, 24 pin connector) All function of front panel (except power switch, CRT intensity, focus, video trigger level, frequency zero, amplitude calibration) are remote-controlled and able to read data of marker and digital storage memory. Interface function: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0
Power source			** VAC ±10%, 50/60 Hz, 230 VA maximum
Dimensions and weight			267 mm (H), 426 mm (W), and 450 mm (D). ≦36 kg
Ambient temperature range in use			0 to 50°C

2.3 Selection Guide

The following units and parts are optional (sold separately).

Table 2-3 Applicationable Instruments and Parts

Name	Performance and Purpose	Remarks
Packet II Hy Personal Computer	16-bit CPU with CRT and mini-floppy disk. Most appropriate as the GP-IB controller.	GP-IB interface: DEU7775A (optional)
Printer DPR7712A	Used as peripheral equipment of Packet II	The GP-IB interface is built in.
Plotter DPL7716A	Used as peripheral equipment of Packet II	The GP-IB interface is built in.
BCD Converter MH037A	Used to connect a device which does not have the GPIB interface to the GP-IB interface so that the connected device can be controlled.	An optional input/output unit to be connected to this converter can be selected according to the purpose of use.
Synthesized Signal Generator MG655A	0.1 to 1300 MHz with resolution 1 Hz. -30 to 130 dBμ with accuracy ±1 dB. Signal purity -133 dBc/Hz (520 MHz, offset 10 kHz). Ideal for testing radio equipment.	
Branch MP640A	DC to 1700 MHz. Attenuation: 40 ± 1 dB (at 100 MHz) Used to branch part of the transmitter output.	
High-Pass Filters MP526A/B/C/D/G	Suppression of fundamental waves, and passing of spurious components of second or higher harmonic waves. 60 MHz band: MP526A 150 MHz band: MP526B 250 MHz band: MP526C 400 MHz band: MP526D 27 MHz band: MP526G	

Table 2-3 Applicationable Instruments and Parts (Cont'd)

Name	Performance and Purpose	Remarks
50 Ω - 70 Ω Impedance Transformer MP614A	10 to 1200 MHz. Impedance is matched when the resistance of the circuit to be measured is 75 Ω.	
CM Directional Coupler MP520A/B/C/D	This coupler is used to measure transmitter fundamental waves and spurious power. This coupler is also used for antenna VSWR measurement. MP520A: 25 to 500 MHz, 75 Ω MP520B: 25 to 1000 MHz, 75 Ω MP520C: 25 to 500 MHz, 50 Ω MP520D: 100 to 1700 MHz, 50 Ω	
Antennas	MP534A dipole antenna: 25 to 520 MHz MP651A dipole antenna: 470 to 1700 MHz MP635A log-periodic antenna: 80 to 1000 MHz MP636A log-periodic antenna: 300 to 1700 MHz	
Pre-amplifier MH648A	0.1 to 1200 MHz. Gain: 30 dB Used to measure faint signals.	
Fuse Holder MP612A	DC to 1000 MHz. Rated power: +15 dBm Fusing power: +35 dBm Used to protect input circuits from excessive power.	

SECTION 3

OPERATION

3.1 General Notes

3.1.1 Power Source

The MS611A operates normally with ** Vac, ±10%, 50/60 Hz power.

Danger

1. To prevent electric shocks, always ground the rear panel "⏚" terminal or the power cord grounding terminal.
2. When replacing fuses, turn OFF the power switch and disconnect the power cord from the electric outlet.

3.1.2 Installation Environment Conditions

The MS611A operates normally at 0 to 50°C, but should not be used in the following places.

a. Places subject to strong vibrations and shocks

b. Places subject to High humidity and dust

c. Places in direct sunlight

d. Places exposed to active gases

Note

If the MS611A is used around at 0°C for a long time and then used at room temperature, short-circuiting may occur due to condensation. To avoid this, allow the MS611A to dry out at room temperature before turning on the power switch.

3.1.3 Notes on Installation

The MS611A contains a cooling fan to keep the internal temperature from rising. Therefore, the MS611A must be installed so that the distance between the rear panel and the wall or the adjacent block is at least 7 cm.
The MS611A must not be installed vertically.

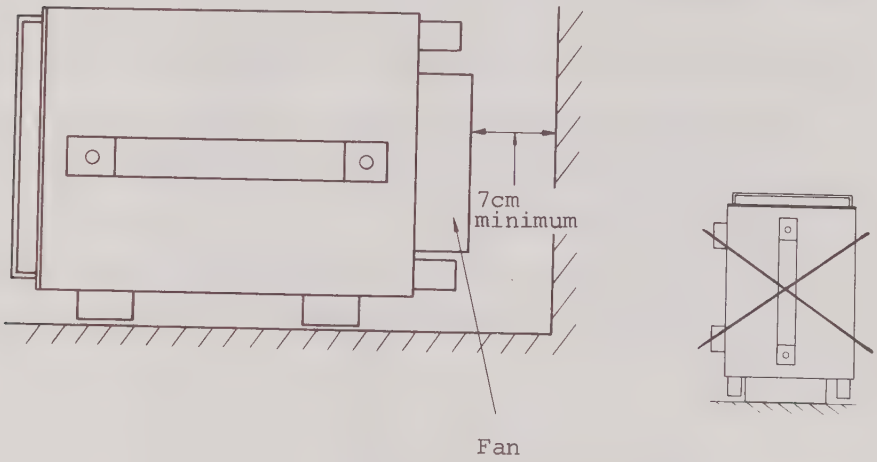


Fig. 3-1 Note for MS611A Setting

3.1.4 Maximum Input Level

Note

If an external signal with a level higher than +25 dBm is applied to the input terminal of the MS611A, the internal circuitry may be destroyed.

3.2 Front Panel Layout

The lamps, switches, and connectors on the front panel are shown in Fig. 3-2. Each operation key is used in one of the following 3 modes:

(a) NORMAL mode

This mode is set when the power of the MS611A is turned ON. In this mode, the MS611A operates using the function indicated on the front panel (see Table 3-1).

(b) SHIFT mode (shift key function mode)

When the KEY FUNCTION SHIFT key is pressed, each key performs other functions. See Section 3.13 for details.

(c) TITLE mode

When the KEY FUNCTION TITLE key is pressed, TITLE mode is set. In this mode, alphabetic characters, numeric characters, and symbols can be input to write a title on the first line of the CRT display screen. The title can consist of 48 or fewer characters. TITLE mode continues until the KEY FUNCTION NORMAL key is pressed.

See Section 3.14 for details.

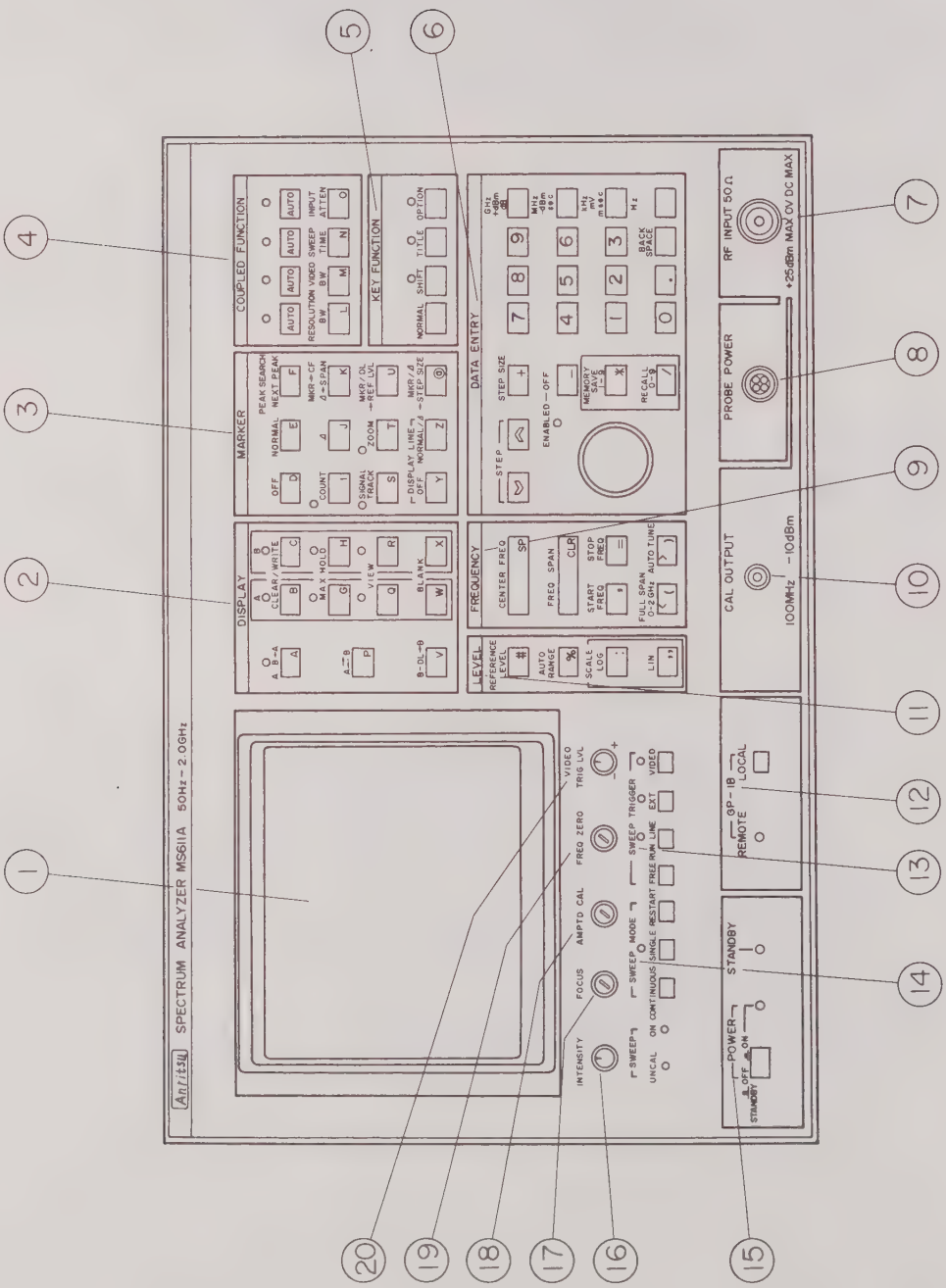


Fig. 3-2 Layout of the Front Panel Controls

Table 3-1 Explanation of the Front Panel (NORMAL mode)

No.	Marking	Explanation	Reference
1		CRT display screen	3.3
2	DISPLAY	Digital storage memory control keys for 2 channels A and B	3.9
3	MARKER	Marker function keys and keys for changing the display line	3.10
4	COUPLED FUNCTION	Keys for controlling resolution bandwidth, video bandwidth, sweep time and input attenuation.	3.11
5	KEY FUNCTION	Keys for changing front panel key functions	3.13
6	DATA ENTRY	Input measurement parameter such as frequency or level	3.6
7	RF INPUT	Signal input connector	
8	PROBE POWER	Connector used to supply power to a probe or another application device	
9	FREQUENCY	Frequency controlling keys	3.7
10	CAL OUTPUT	100 MHz, -10 dBm calibration signal come out from this connector	
11	LEVEL	Level control keys	3.8
12	GP - IB	Key used to select LOCAL mode or REMOTE mode when using GP-IB	
13	SWEEP TRIGGER	Sweep trigger mode select keys	3.12.2
14	SWEEP MODE	Sweep mode select keys	3.12.1
15	POWER	Power switch. When this switch is set to ON, the power is turned ON and the lamp goes ON.	3.5.1
16	INTENSITY	CRT intensity control knob	
17	FOCUS	CRT focus adjustment knob	
18	AMPTD CAL	gain adjustment knob	3.5.1
19	FREQ ZERO	Frequency zero adjustment knob	3.5.1
20	VIDEO TRIG LVL	Trigger level adjustment knob used in video trigger mode	3.12.2

3.3 CRT Display

The CRT of the MS611A displays the input signal spectrum, measurement parameters and frequency and level of marker-point. ENTRY FUNCTION and ENTRY DATA indicate the function and data which are being set. The displayed parameters can be changed.

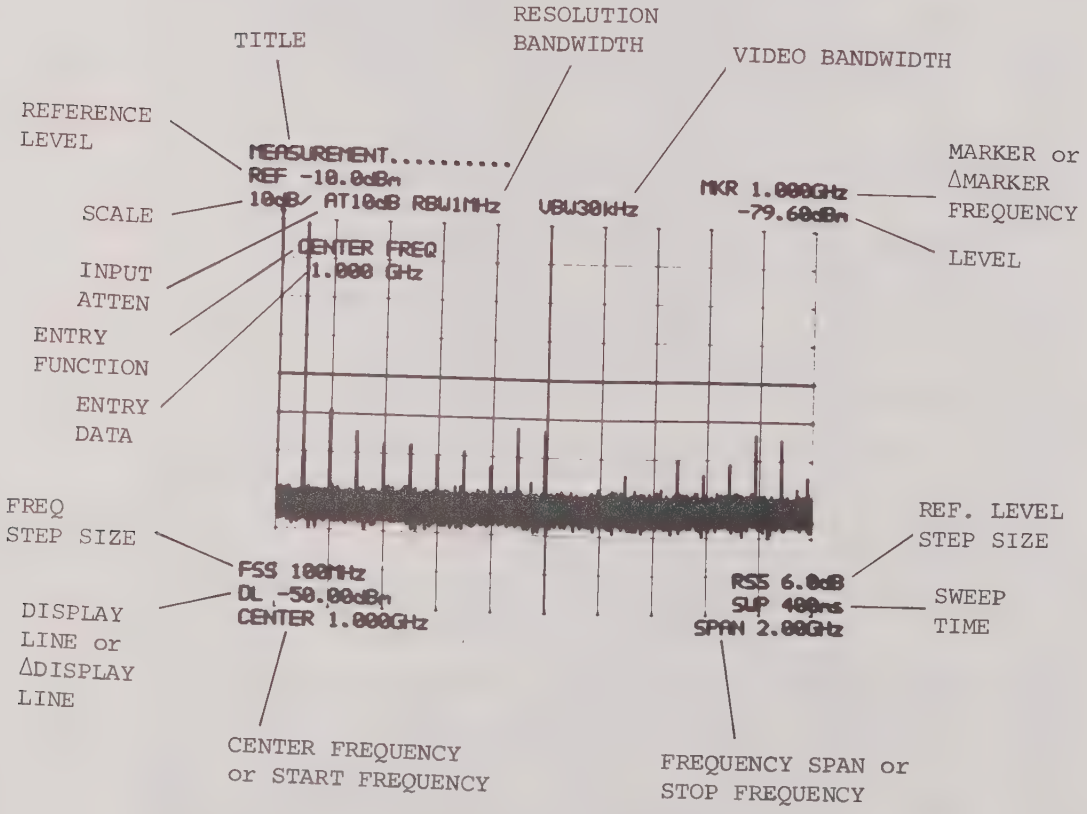


Fig. 3-3 CRT Display

3.4 Rear Panel Layout

Fig. 3-4 shows the layout of the switches and connectors on the rear panel, and Table 3-2 shows their functions.

Note

Usually, connect the REF OUTPUT 10 MHz connector (30) to the REF INPUT 10 MHz TTL connector (31) through a U-link. When an external reference signal (10 MHz) is to be used, disconnect the U-link and supply the reference signal to the REF INPUT 10 MHz TTL connector (31).

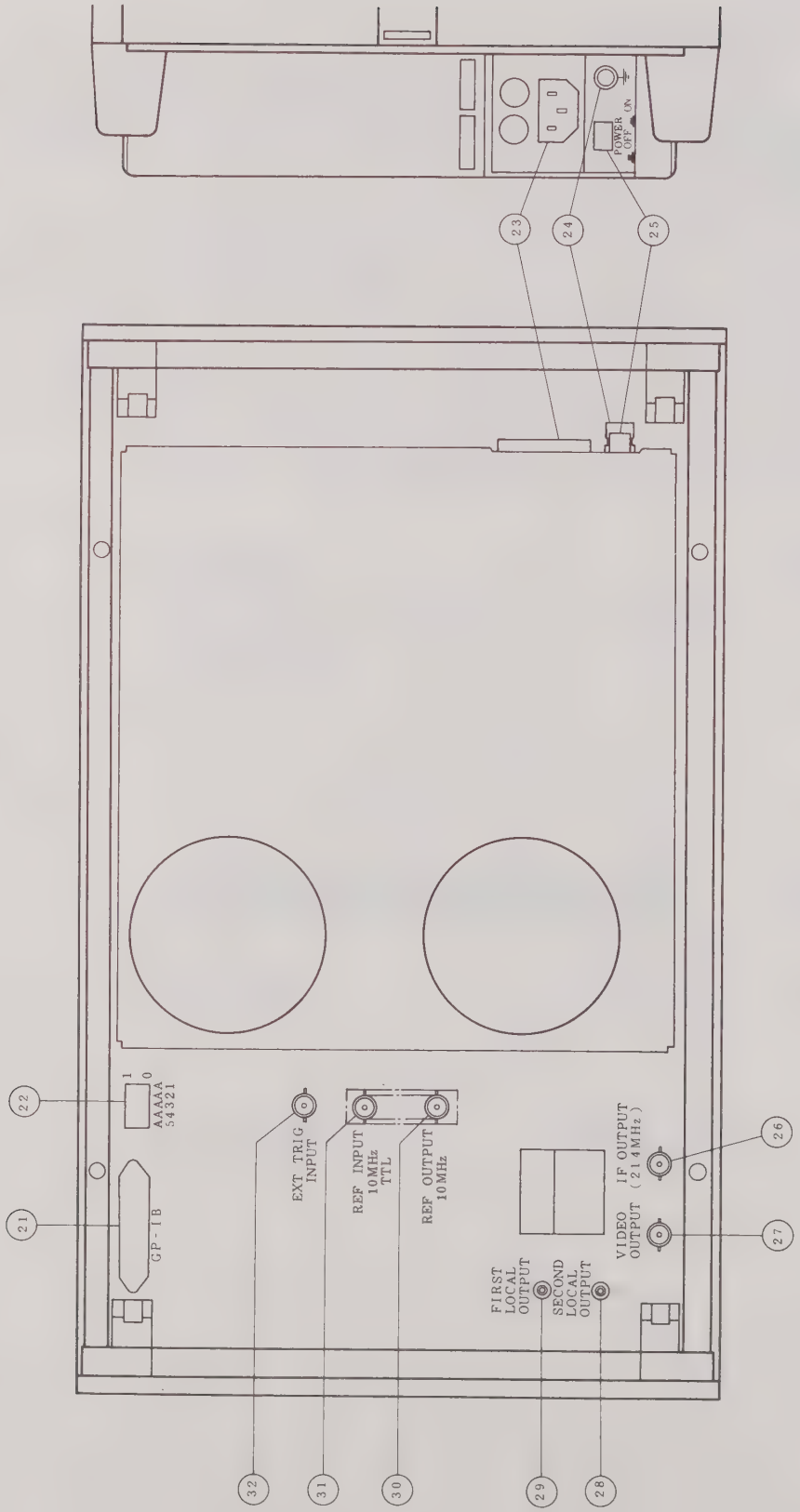


Fig. 3-4 Layout of the Rear Panel Controls

Table 3-2 Explanation of the Rear Panel

No.	Marking	Explanation	Reference
(21)		Connector for GP-IB connection	Section 4
(22)		GP-IB address switch	4.3
(23)		AC inlet with fuse holder. Used for connecting the power cord.	3.1.1
(24)		Grounding terminal	3.1.1
(25)		Power switch	3.5.1
(26)	IF OUTPUT (21.4 MHz)	Connector used to output a signal from the IF circuit.	
(27)	VIDEO OUTPUT	Connector used to output a detected signal.	
(28)	SECOND LOCAL OUTPUT	Connector used to output a second local signal	
(29)	FIRST LOCAL OUTPUT	Connector used to output a first local signal	
(30)		Connector used to output the reference oscillator (10 MHz)	
(31)		Connector used to input the reference frequency (10 MHz) Usually, this connector is connected to (30) through a U-link.	
(32)		Connector used for external trigger input	3.12.2

3.5 Operation

This section explains how to operate the MS611A briefly. For details on each function, see section 3.6 and later.

3.5.1 Power ON

(1) Before turning ON the POWER switch on the front panel, set the POWER switch on the rear panel to the ON position (usually, this POWER switch is kept in the ON position).

When the POWER switch on the rear panel is to the ON position and the POWER switch on the front panel is set to the STAND BY position, the STAND BY LED on the front panel goes on, power is supplied only to the reference oscillator circuit, and the reference frequency is stabilized.

Next, when the POWER switch on the front panel is turned to the ON position, the MS611A operates usually. (If the POWER switch on the rear panel is turned OFF, all power of the MS611A is turned off even if the POWER switch on the front panel is set to the ON position.)

(2) Immediately after the POWER switch on the front panel is turned on, all the LEDs on the front panel momentarily go on, the initial state parameter is set, and then the CRT and LEDs on the front panel are set according to the parameter.

Fig. 3-5 is an example of the CRT display.

When the RECALL switch and then the 0 key are pressed in initial state, the parameters set at the previous POWER OFF state are recalled. Therefore, if the initial state is set by accidentally turning off the power or because of a service interruption, the previous state can be recalled by pressing RECALL 0.

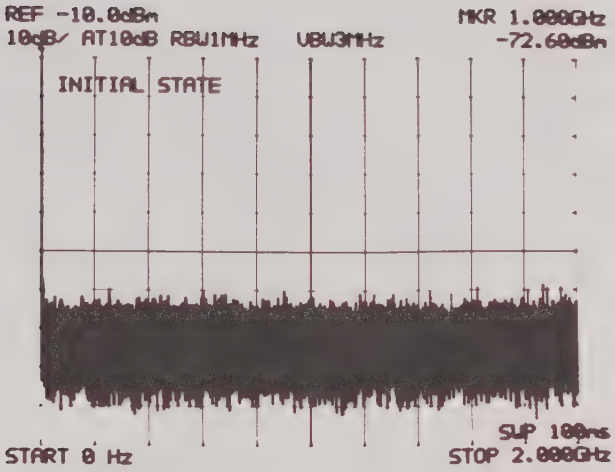


Fig. 3-5 Initial State

(3) The MS611A has an AMPTD CAL control for gain adjustment and FREQ ZERO control for frequency zero adjustment.

The gain and frequency zero controls can be calibrated as follows:

1. Connect the RF INPUT connector to the CAL OUTPUT connector with an accessory cable.
2. Press the FULL SPAN key.
3. Press the SHIFT key and then the SWEEP MODE RESTART key. Parameters are automatically set as follows:

CENTER FREQUENCY	:	100 MHz
FREQUENCY SPAN	:	100 kHz
REFERENCE LEVEL	:	-10 dBm
RESOLUTION BANDWIDTH	:	100 kHz
SCALE	:	LOG 1 dB/div

4. Adjust the AMPTD CAL control (18) so that the marker level is at -10.0 dBm.
5. Press the SHIFT key and then the SWEEP TRIGGER LINE key.

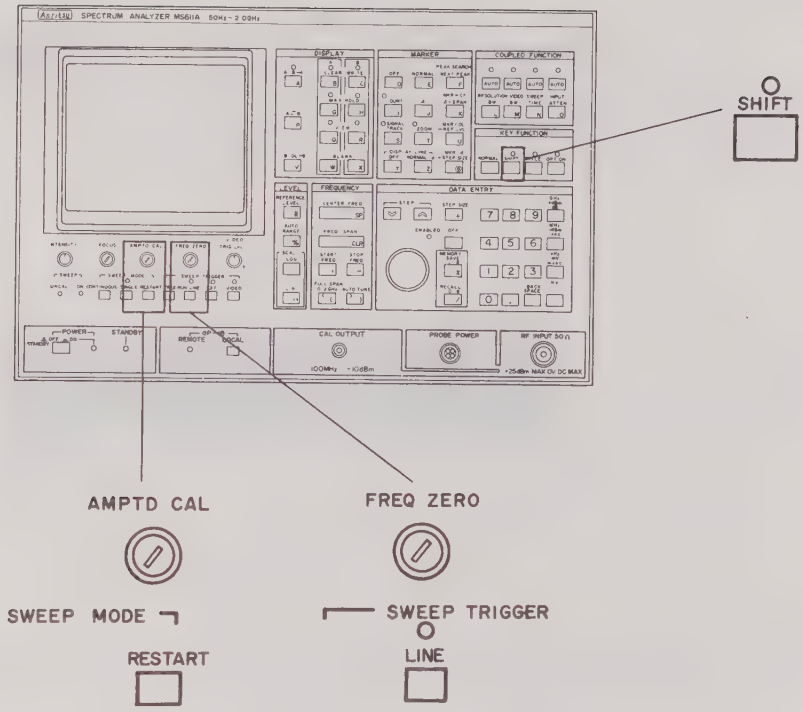


Fig. 3-6 Initial Setting

Parameters are set as follows:

CENTER FREQUENCY	:	100 MHz
FREQUENCY SPAN	:	0 Hz
REFERENCE LEVEL	:	-7 dBm
RESOLUTION BW	:	30 Hz
SCALE	:	LOG 1 dB/div
SWEEP TIME	:	10 sec

6. Adjust the FREQ ZERO control (19) so that the maximum display value is obtained.

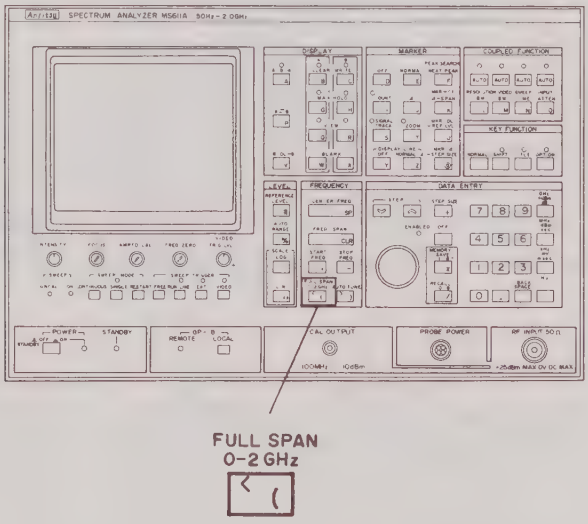
Note: Even if the current reference level is represented in dBμ, the REFERENCE LEVEL unit is changed to dBm by setting AMPTD CAL (18), FREQ ZERO (19).
In this case, REF LEVEL unit is returned to dBμ by setting RECALL (6) or FULL SPAN (9).

3.5.2 Basic Operations

The basic operations of the MS611A are setting frequencies (tuning) and level. The following are examples of basic operations when the CAL OUTPUT connector is connected to the RF INPUT connector.

(1) Using AUTO TUNE

(a) First, press the FULL SPAN key (9). Full sweep (0 to 2 GHz) occurs, and the COUPLED FUNCTION is set to AUTO COUPLED mode.



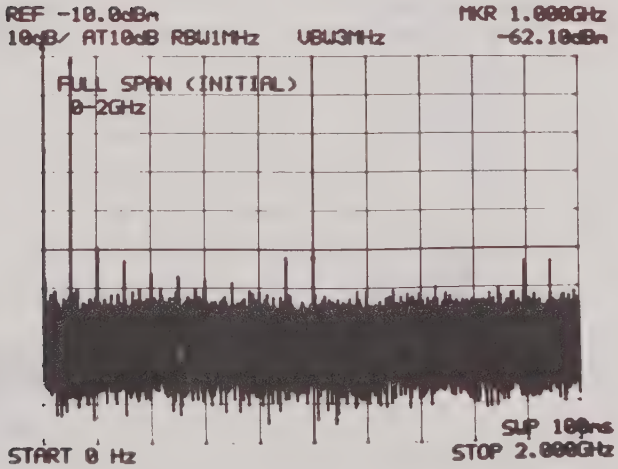
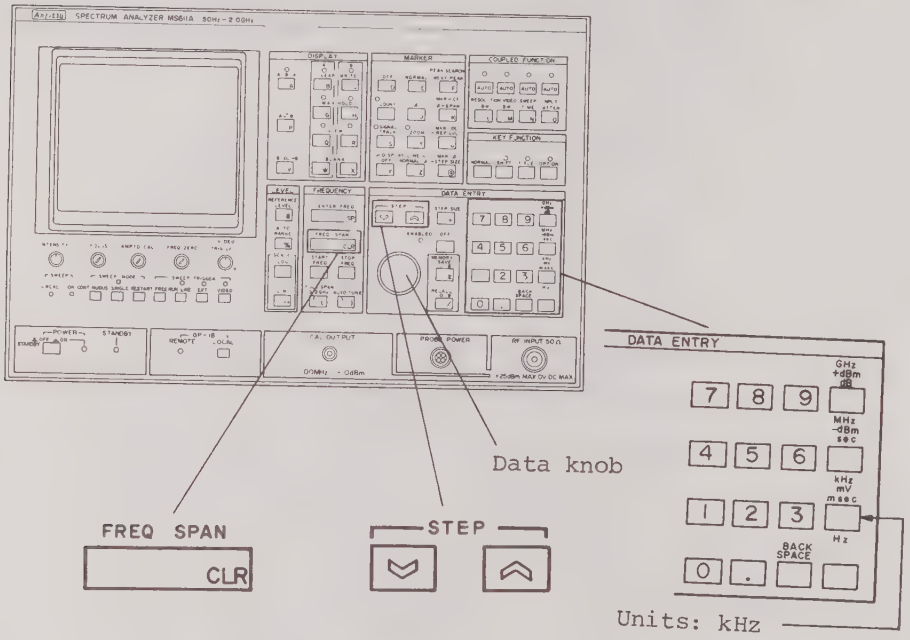


Fig. 3-7 Setting FULL SPAN

(b) Next, set the frequency span to the desired value (e.g., 100 kHz). This is done by pressing the FREQ SPAN key and then by pressing the 1, 0, and 0 keys (numeric value) and the kHz key (unit). (The frequency span can be set to 100 kHz by using the STEP key or the data knob instead of the number/units keys.)



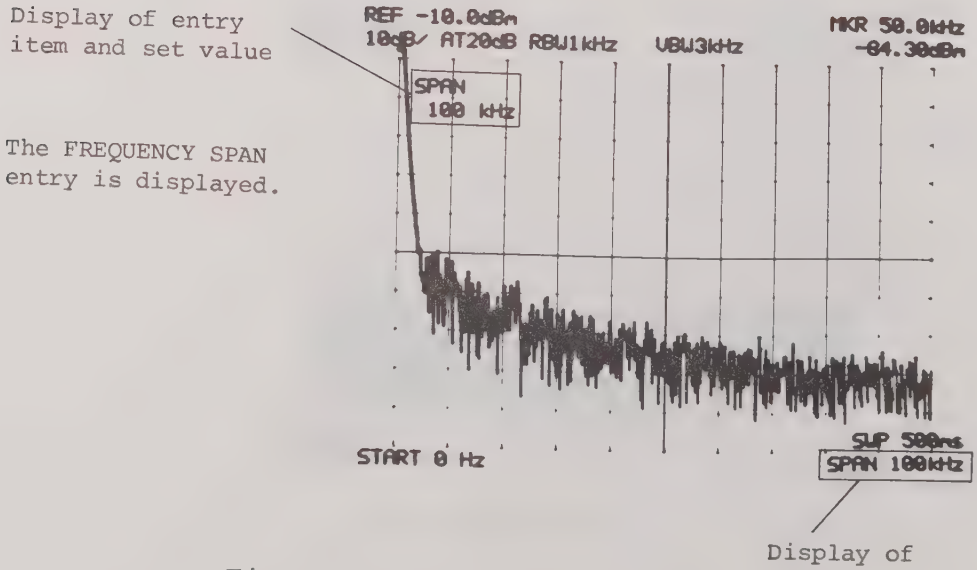


Fig. 3-8 Setting FREQ SPAN

(c) Press the AUTO TUNE key. Automatic tuning to the highest-level signal (20 MHz to 2 GHz) is done. In this example, the 100 MHz signal is displayed on the CRT screen. The frequency of this signal is set as the CENTER FREQUENCY, and the level is set as the REFERENCE LEVEL.

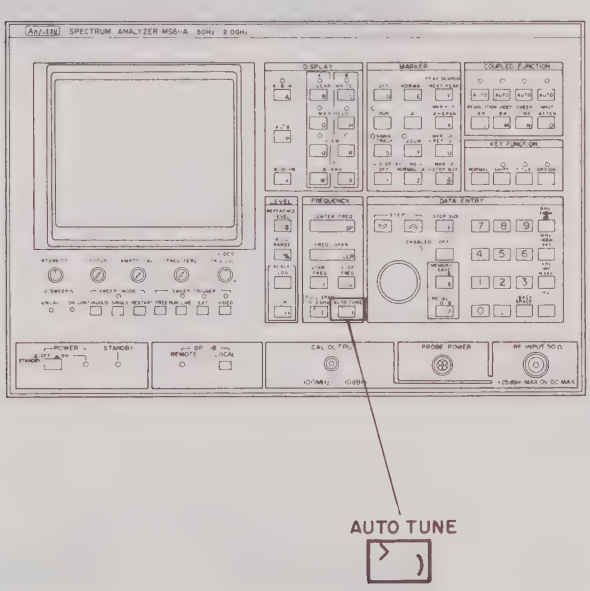
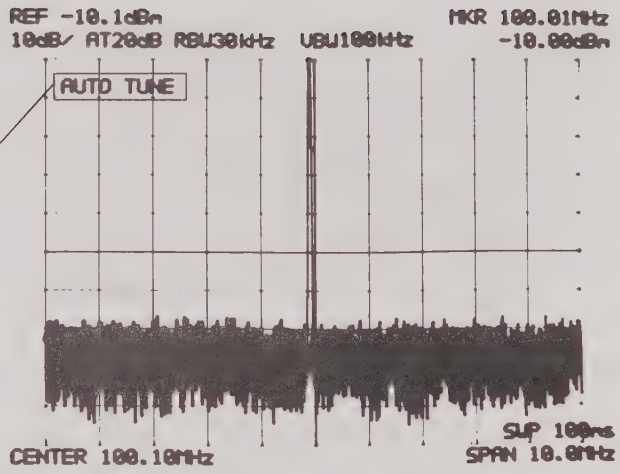


Fig. 3-9 Setting AUTO TUNE

The indicates that the AUTO TUNE routine is being executed.



The "AUTO TUNE" displayed is deleted when the AUTO TUNE routine ends.

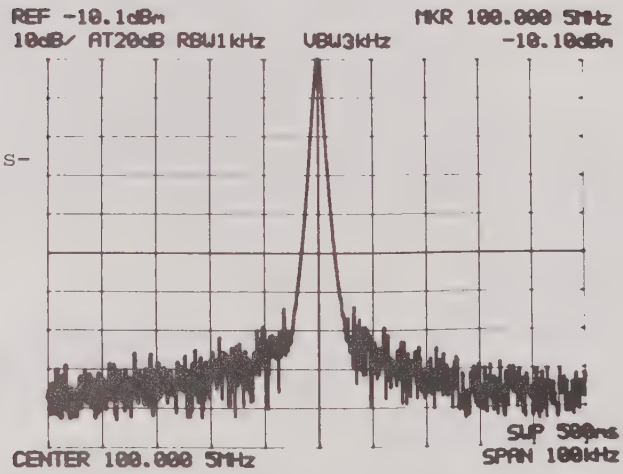


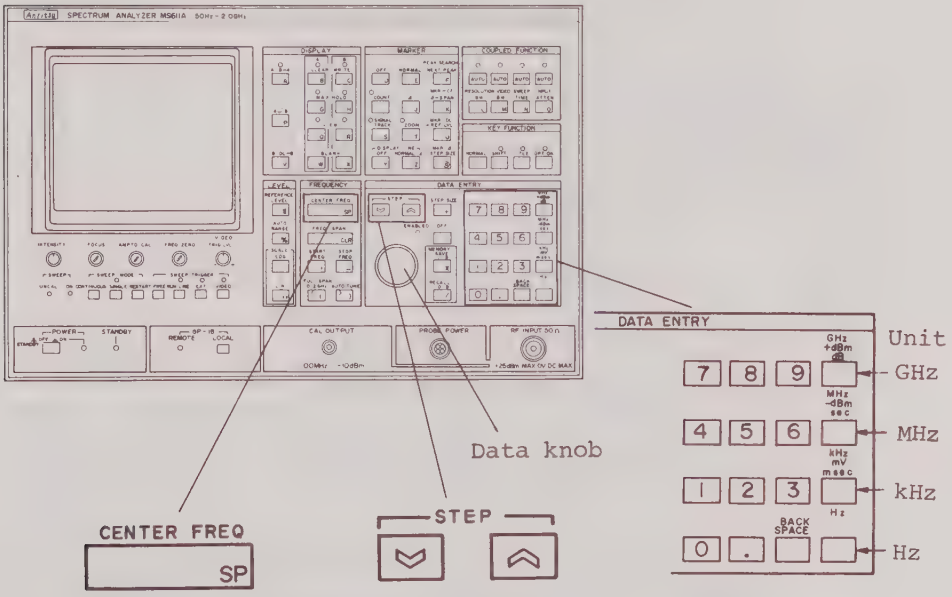
Fig. 3-10

Note: In AUTO TUNE, the frequency of the peak signal is used as the CENTER FREQUENCY. However, there may be some display errors in the CENTER FREQUENCY value.

So the displayed value for "AUTO TUNE" is normal in the range from 99.9980 to 100.0020 MHz.

(2) Directly setting the frequency and level

(a) First, set the CENTER FREQUENCY.
For example, the CENTER FREQUENCY can be set to 300 MHz by pressing the CENTER, 3, 0, 0, and MHz key. (This setting can also be done by using the STEP keys ⩒ and ⩓ or the data knob instead of the number/units keys.)



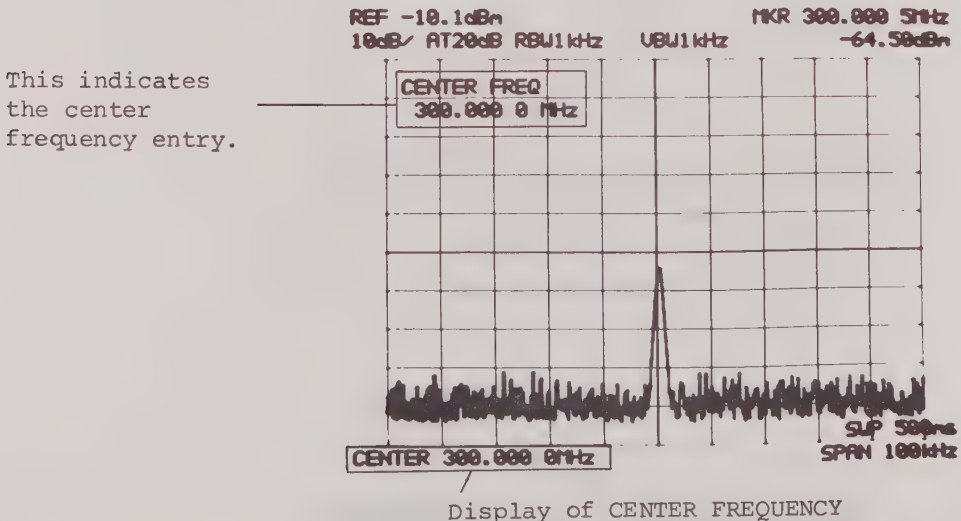
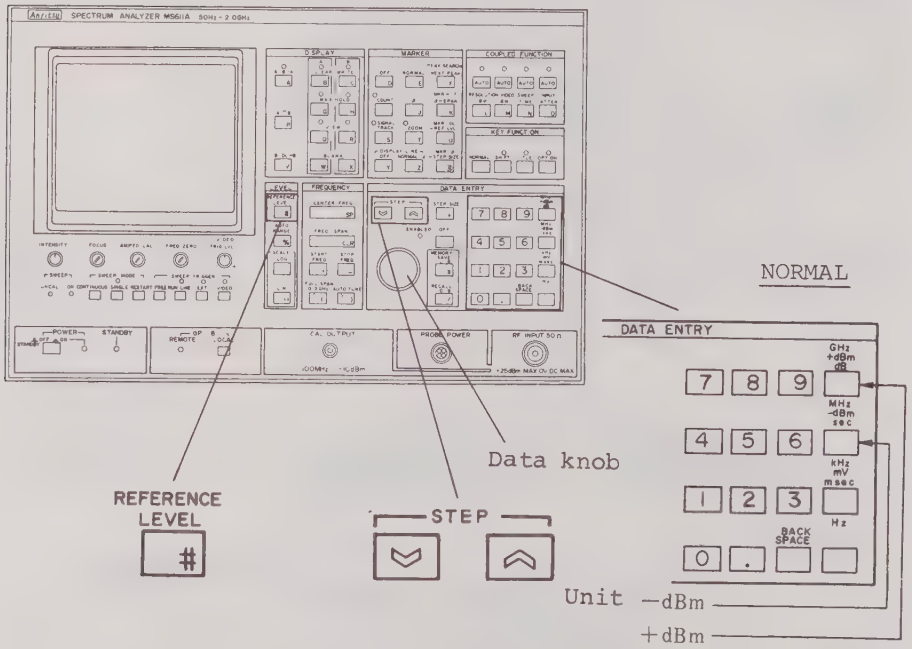


Fig. 3-11 Setting CENTER FREQUENCY

(b) Next, set the FREQUENCY SPAN in the same way as explained in (1)-(b).

(c) Set the FREQUENCY LEVEL
For example, the REFERENCE LEVEL can be set to -30 dBm by pressing the REFERENCE LEVEL, 3, 0, and -dBm keys. (This setting can also be done by using STEP keys ⩒ and ⩓ or the data knob instead of the number/units keys.)



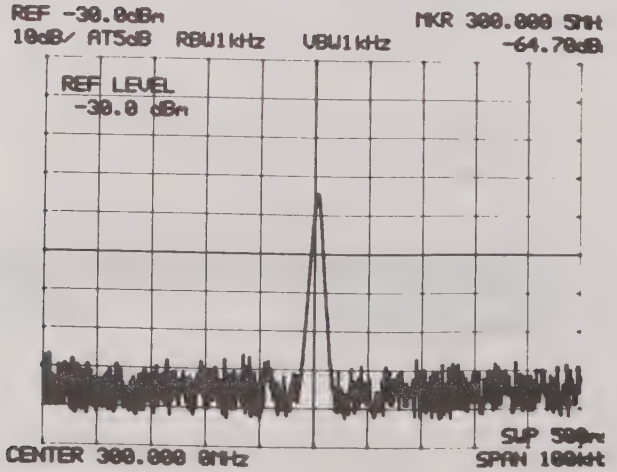


Fig. 3-12 Setting REFERENCE LEVEL

3.5.3 Measuring the Frequency and Level

(1) Using the marker to measure the frequency and level

The frequency and level at the marker point are displayed at the upper right of the screen. The frequency and level of a signal can thus be known by moving the marker point to the signal.

Marker

The marker point in NORMAL marker mode can be moved by pressing the MARKER NORMAL key and then operating the data knob or STEP keys. (The marker point can also be moved by inputting the new marker point frequency with the number/units keys.)

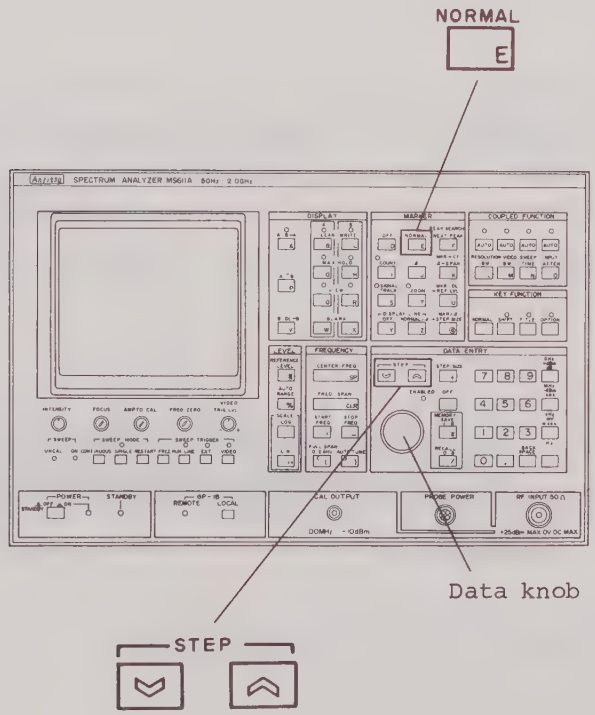


Fig. 3-13 NORMAL Marker Setting (1/2)

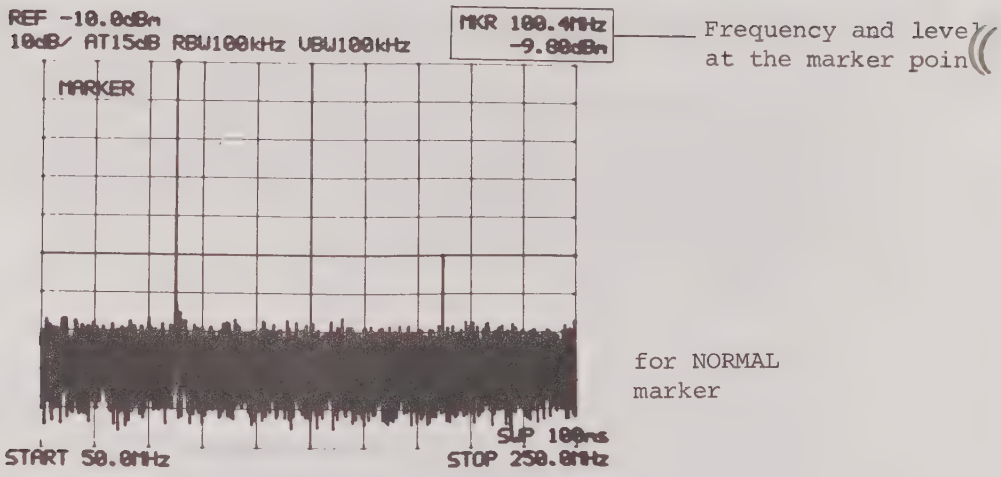
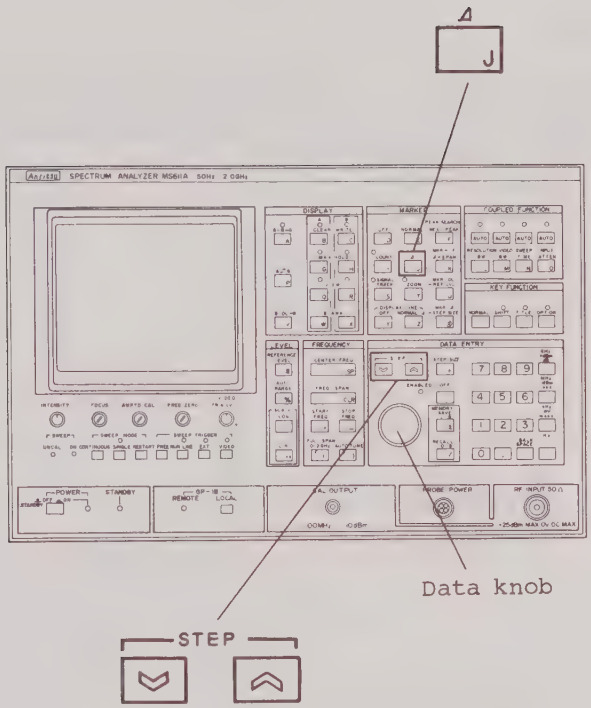


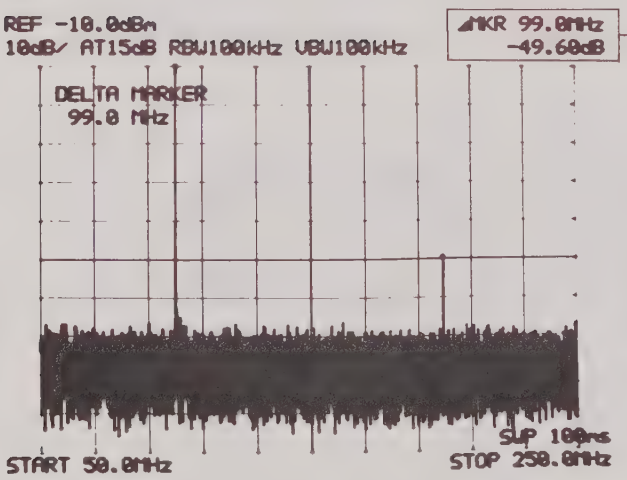
Fig. 3-13 NORMAL Marker Setting (2/2)

Δ Marker

When the MARKER Δ (delta) key is pressed, the frequency difference and level difference between two marker points are displayed. When the marker mode is changed from NORMAL to Δ (delta), the current marker point is set as the reference marker, and its frequency and level are stored.

The other marker point (active marker) can be moved using the step keys or the data knob. (The frequency difference of these two marker points can be input using the number/units keys.)



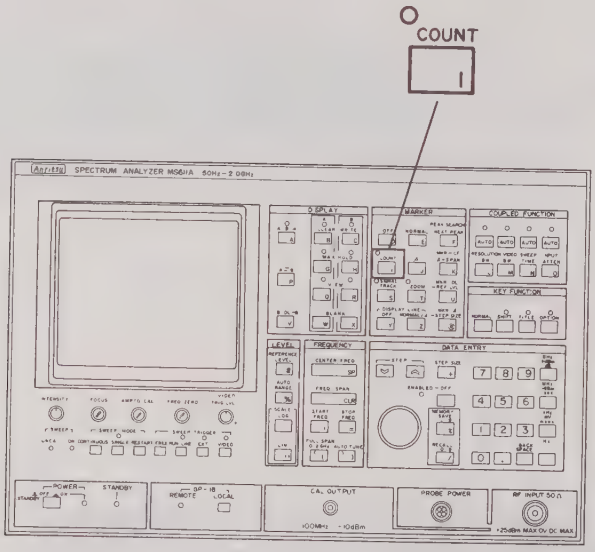


Frequency difference and level difference in Δ marker mode

Fig. 3-14 Δ Marker Setting

(2) COUNT mode

The signal frequency can be measured more accurately by pressing the COUNT key. In COUNT mode, the frequency of the signal located at the marker point is counted and displayed in units of 1 Hz.



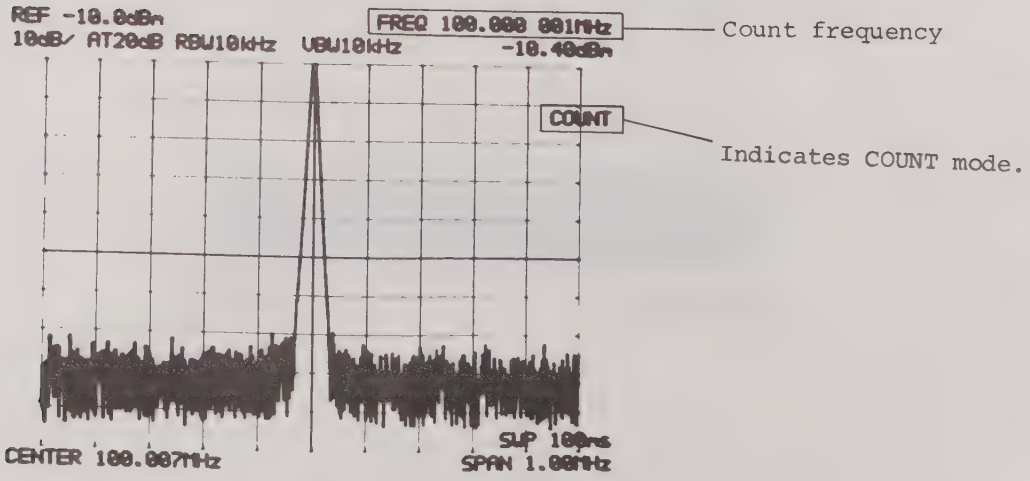


Fig. 3-15 COUNT Marker Setting

3.5.4 Save/Recall of Measurement Parameters

Measurement parameters such as the frequency and level, can be saved (stored) internal registers, and recalled later.

There are 10 registers, register 0 through register 9. Register 0 is used to automatically save the status preceding the current parameter setting status. The user can recall data from register 0, but cannot save data to register 0.

For registers 1 through 9, the user can both save and recall data.

For example, saving to register 3 and recalling from register 4 can be done by pressing the SAVE, 3, RECALL, and 4 keys. The actual operation is done when the corresponding numeric key is pressed.

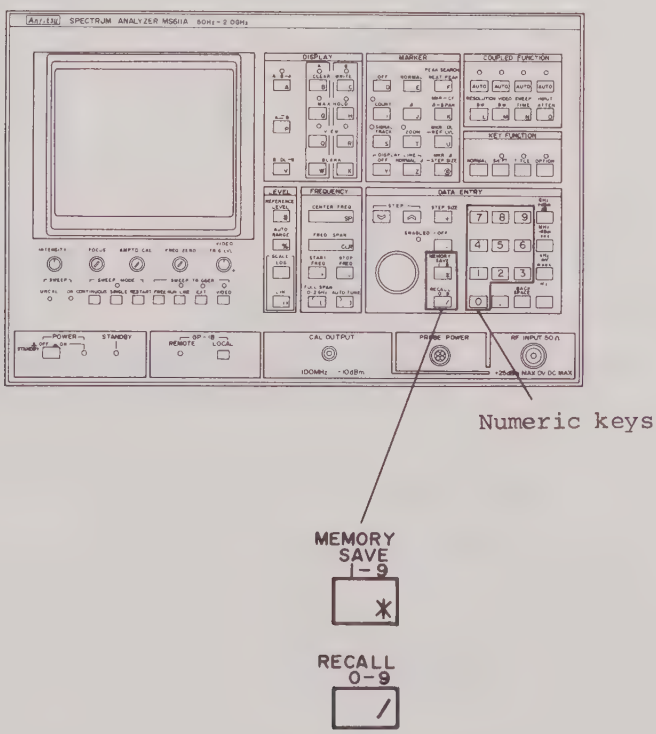


Fig. 3-16 SAVE/RECALL Setting (1/2)

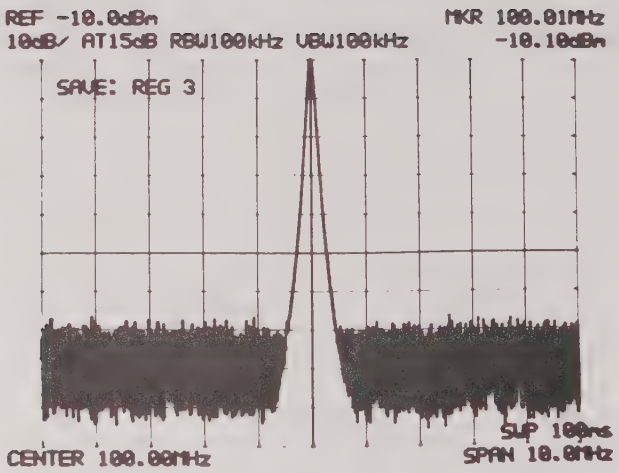


Fig. 3-16 SAVE/RECALL Setting (2/2)

3.5.5 SHIFT Key Function

When the KEY FUNCTION SHIFT key is pressed and then a key is pressed, another function which is assigned to the key is enabled.

For an explanation of the SHIFT key function, see section 3.13.

3.5.6 Automatic Measurement

The MS611A can be controlled remotely using the GP-IB standard interface bus.

When the Packet II Hy personal computer or another computer is used as the GP-IB controller, the procedures for automatic measurement can be programmed using simple program codes.

For an explanation of the GP-IB interface, see Section 4.

3.6 DATA ENTRY

When setting the frequency, level, or marker, first press a function key and then input data.

There are three ways to input data:

(a) Using the number/units keys
Directly inputs the numeric value.

(b) Using the STEP keys
Changes set values quickly in set steps.

(c) Using the data knob
Continuously sets values in fine steps.

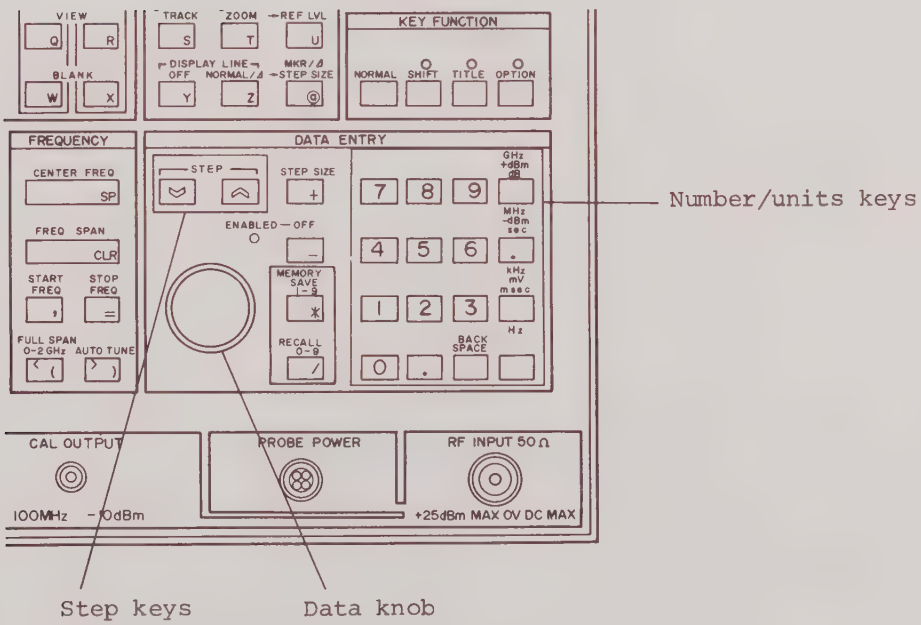


Fig. 3-17 Setting DATA ENTRY

When a function key (5) is pressed, the ENABLED lamp goes on and data for the selected function can be input.

After 1 data record is input, another data record can be input by one of the above methods (a) through (c). This function mode continues until another function key is pressed.

During numeric data input using the numeric keys, neither the STEP keys nor the data knob can be used. When the STEP keys or data knob are used, press the function key again.

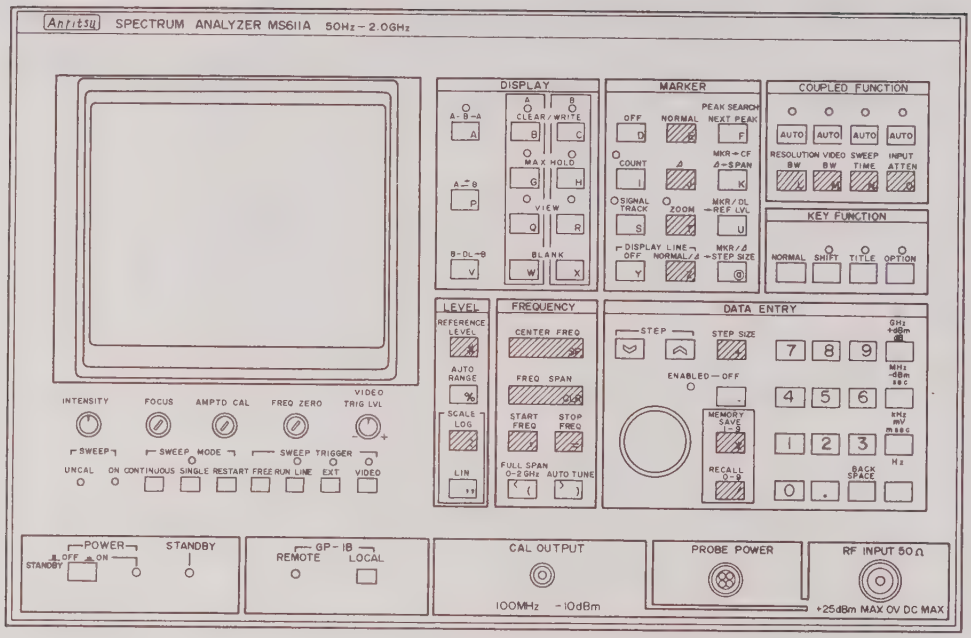
3.6.1 DATA ENTRY Functions

After a function key is pressed, a data entry can be input using the functions shown in Table 3-3.

Table 3-3 DATA ENTRY Functions

(o indicates that input is possible, and × indicates that input is impossible.)

Function	Number/ units keys	Step keys	Data knob	Reference	Remarks
CENTER FREQ	o	o	o	3.7.1	
FREQ SPAN	o	o	o	3.7.2	
START FREQ	o	o	o	3.7.1	
STOP FREQ	o	o	o	3.7.1	
REFERENCE LEVEL	o	o	o	3.8.1	
SCALE LOG	o	o	×	3.8.3	
MARKER NORMAL	o	o	o	3.10.1	
MARKER (DELTA)	o	o	o	3.10.2	Negative data can be entered.
ZOOM	o FREQ SPAN	o FREQ SPAN	o MAR-KER	3.10.2	
DISPLAY LINE NORMAL	o	o	o	3.10.8	
DISPLAY LINE (DELTA)	×	o	o	3.10.8	SHIFT key function
RESOLUTION BW	o	o	×	3.11.1	
VIDEO BW	o	o	×	3.11.2	
SWEEP TIMEQ	o	o	o	3.11.3	
INPUT ATT	o	o	×	3.11.4	
INPUT ATT (IF FIXED)	o	o	×	3.11.4	SHIFT key function
SAVE/RECALL	o (only numeric data)	×	×	3.5.4	
FREQUENCY STEP SIZE	o	×	×	3.6.6	
LEVEL STEP SIZE	o	×	×	3.6.6	
LEVEL STEP SIZE	o	×	×	3.6.6	
VIDEO AVERAGING count	o	×	×	3.13.3	SHIFT key function



▨ indicates keys usable for DATA ENTRY.

3.6.2 DATA ENTRY Display

When a function key is pressed, the name of the selected function is displayed at the upper left of the screen.

For example, when the CENTER FREQ key is pressed, the CENTER FREQ function is displayed as shown in the figure to the right.

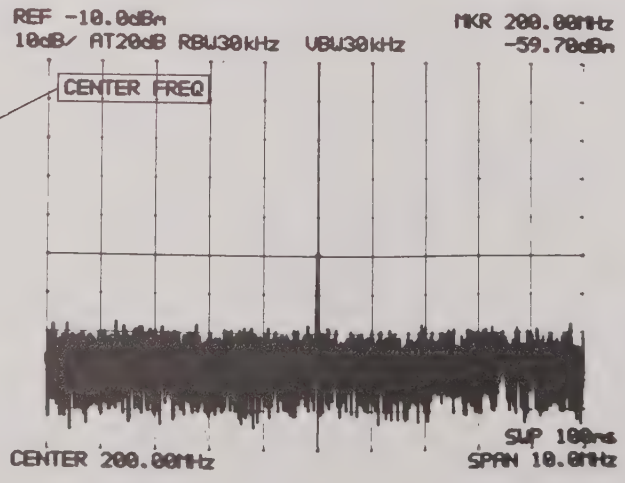
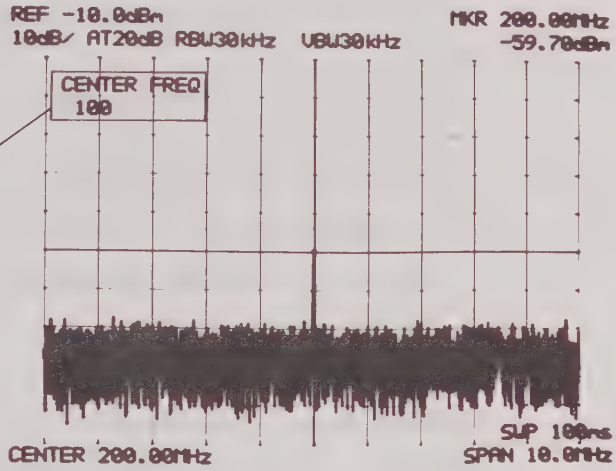


Fig. 3-18 Display of CENTER FREQUENCY Data Entry (1/2)

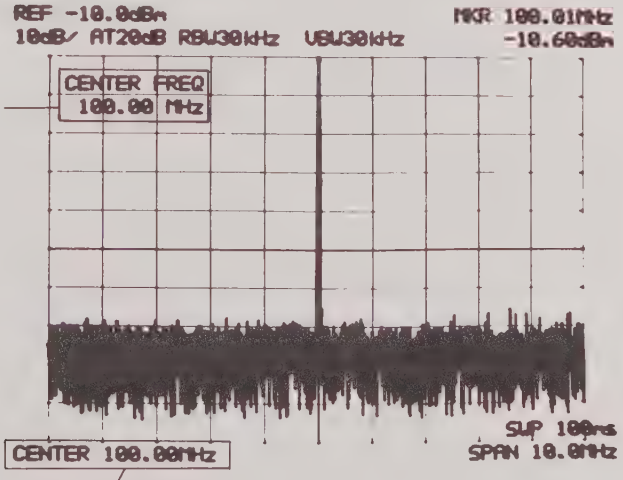
Next, when numeric keys are pressed, the input numeric characters are sequentially displayed.

When the 1, 0 and 0 keys are pressed, 100 is displayed as shown in the figure to the right.



Input is completed by pressing a unit key.

As input display, the input format is changed to the standard format.



This display changes when internal setting is changed.

Fig. 3-18 Display of CENTER FREQUENCY Data Entry (2/2)

Note: When the standard format is used, the units appropriate for the input numeric value are automatically selected and the number of digits to be displayed is determined according to the readout resolution on the CRT.

For example, when a frequency is input, its units are selected as follows:

1000 MHz or higher frequency:	GHz
1 MHz or higher frequency:	MHz
1 kHz or higher frequency:	kHz
Less than 1 kHz:	Hz

CENTER FREQ 100 MHz can be input by entering 0.1 GHz, 100000 kHz, 100000000 Hz, or 100.000000 MHz. However, when the unit key is pressed, the input value is displayed as 100.0 MHz (the number of digits to be displayed is determined according to the FREQ SPAN value. The digits below the decimal point are displayed by grouping adjacent 3 digits and delimiting each group by a blank.

3.6.3 Number/Units Keys

- Up to 11 numeric digit can be input before pressing a unit key. When a unit key is pressed, the number of effective digits is determined according to the selected function. The remaining digits are discarded by rounding down.

- If an incorrect numeric value is input, the displayed numeric characters can be deleted one by one by pressing the BACK SPACE key.

  For example,
  when the 1, 0, 0, 2, 5, BACK SPACE, BACK SPACE, 3, and 6 keys are pressed, the final input value is 100.36.

- When a decimal fraction is to be input, the 0 in the units digit can be omitted. For example, . 2 can be input instead of 0.2.

- When no numeric value is input but a unit key is input, the following operations.

  When the REFERENCE LEVEL function is selected.

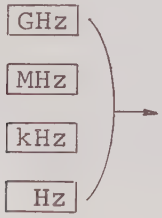
  [+dBm] ⟶ dBm is set as the unit.
  (When unit dBμ is selected by SHIFT KEY function, dBμ is set as the unit.)

  [mV] / [μV] ⟶ Volts is set as the unit.

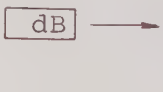
  When the SCALE LOG function is selected.

  [dB] ⟶ 10 dB/div is input.

When the FREQUENCY STEP SIZE function is selected.



When the LEVEL STEP SIZE function is selected.



When other functions are selected, this unit key operation is invalid.

- When the SAVE or RECALL key is pressed, the operation ends after only 1 numeric character is input.

- When the REFERENCE LEVEL function is selected, negative data can be input using the -dBm unit key.

  For example, -10 dBm can be input by pressing the 1, 0, and -dBm keys.

  When the Δ MARKER function is selected, a negative frequency difference can be input using the SHIFT key

  For example, -10 MHz can be input by pressing the SHIFT, ENABLED-OFF, 1 0, and MHz keys.

  Entering a negative value by using the SHIFT key can be done only when the Δ MARKER function is selected.

3.6.4 STEP Keys

- Initial step sizes are determined for each function, as follows:

Table 3-4 Correspondence of Functions to Initial Step Sizes

Function	Step size
CENTER FREQ	Approx. 1/10 of FREQ SPAN value (Only the highest-order digit is valid.)
FREQ SPAN	1-2-5 sequence
START FREQ	Approx. 1/10 of FREQ SPAN value (Only the highest-order digit is valid.)
STOP FREQ	Approx. 1/10 of FREQ SPAN value (Only the highest-order digit is valid.)
REFERENCE LEVEL	Log: 10 dB/div, 5 dB/div ..... 5 dB 1 dB/div ..... 2 dB 1 dB/div ..... 1 dB LIN: Equivalent to 5 dB
SCALE LOG	1-2-5 sequence
MARKER NORMAL	Equivalent to 1 div on the horizontal axis
MARKER Δ	Equivalent to 1 div on the horizontal axis
ZOOM	FREQ SPAN 1-2-5 sequence
DISPLAY LINE NORMAL	Equivalent to 1 div on the vertical axis
DISPLAY LINE Δ	Equivalent to 1 div on the vertical axis
RESOLUTION BW	1-3 sequence
VIDEO BW	1-3 sequence
SWEEP TIME	1-2-5 sequence
INPUT ATTEN	5 dB
INPUT ATTEN (IF FIXED)	5 dB

- For an explanation on inputting the frequency step size and level step size, see section 3.6.6.

3.6.5 Data Knob

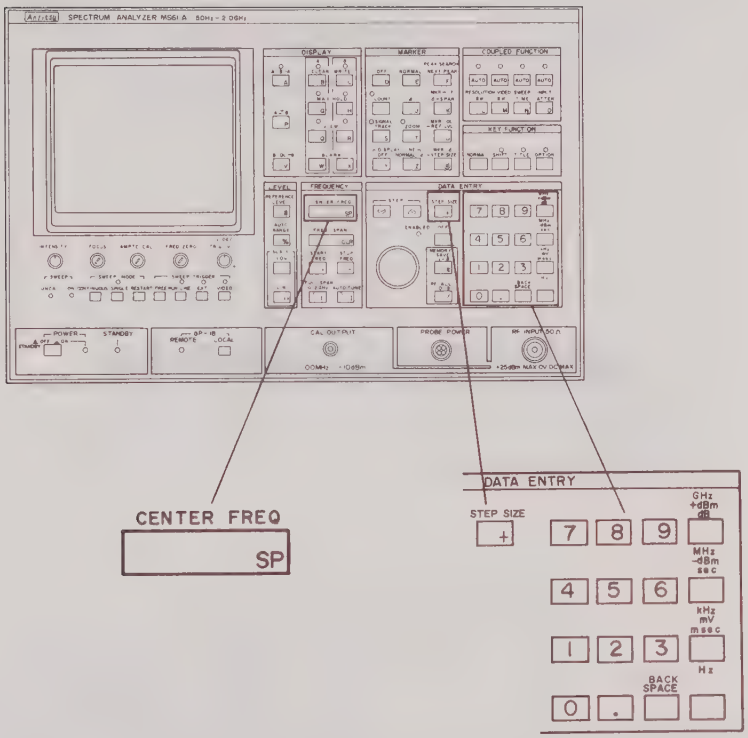
- Turning the data knob clockwise increases the set value.
  Turning it counterclockwise decreases the set value.

- The data knob is useful for consecutively changing the set value in fine steps. The step size is determined from the data knob turning speed. That is, when the data knob is turned slowly, the set value changes in finer steps. On the other hand, when the data knob is turned quickly, the set value changes in coarser steps. Therefore, for example, when moving the marker point to a signal position, turning the data knob quickly rapidly moves the marker point rapidly to the desired signal and turning the knob slowly allows for accurate adjustment.

3.6.6 STEP SIZE

(1) Setting the frequency step size

First, press the CENTER FREQ, START FREQ, or STOP FREQ key. Next, press the STEP SIZE key. Then, input a step size by using the number/units keys. This step size is used when the CENTER FREQ, START FREQ, or STOP FREQ value is to be changed using the STEP keys ⩔ and ⩓ . For example, FREQ STEP SIZE can be set to 10 MHz by pressing the CENTER FREQ, STEP SIZE, 1, 0, and MHz keys. In this case, the START FREQ or STOP FREQ key can be used instead of the CENTER FREQ key. The step size can be returned to the initial value (see Table 3-4) by pressing the CENTER FREQ, STEP SIZE, and GHz keys. In this case, the START FREQ or STOP FREQ key can be used instead of the CENTER FREQ key, and the MHz, kHz or Hz key can be used instead of the GHz key.



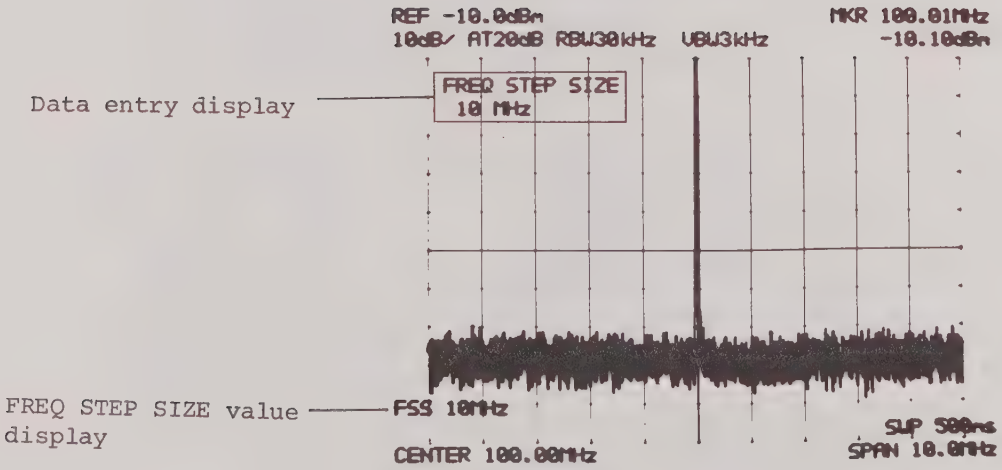


Fig. 3-19 STEP SIZE Data Entry

(2) Setting the level step size

Press the REFERENCE LEVEL key and the STEP SIZE key, and input at step size by using the number/units keys. The step size unit must be dB.

This step size is used when the reference level is to be changed using the STEP keys ⩒ and ⩓ .

For example, LEVEL STEP SIZE can be set to 6 dB by pressing the REFERENCE LEVEL, STEP SIZE, 6, and dB keys.

The step size can be returned to the initial value (see Table 3-4) by pressing the REFERENCE LEVEL, STEP SIZE, and dB keys.

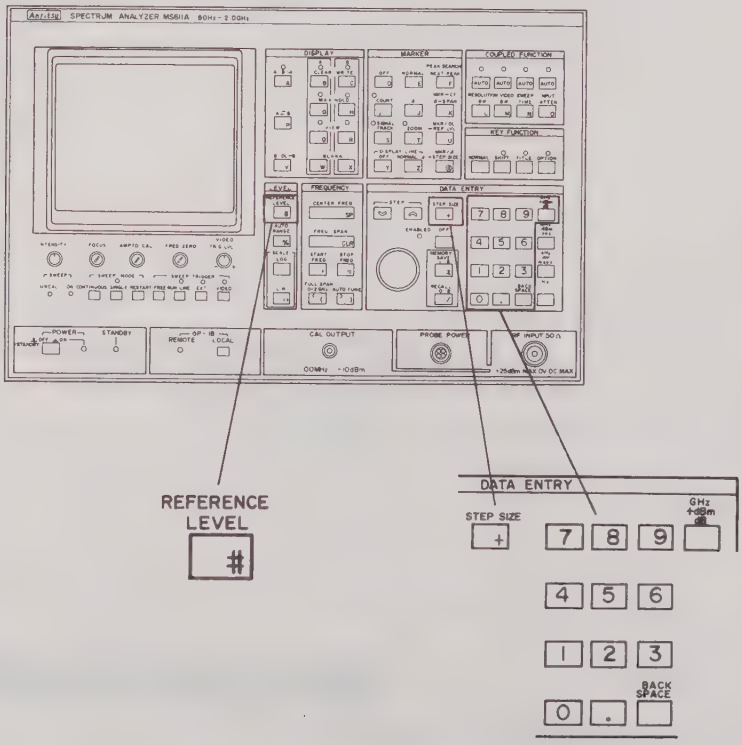


Fig. 3-20 STEP SIZE Setting (1/2)

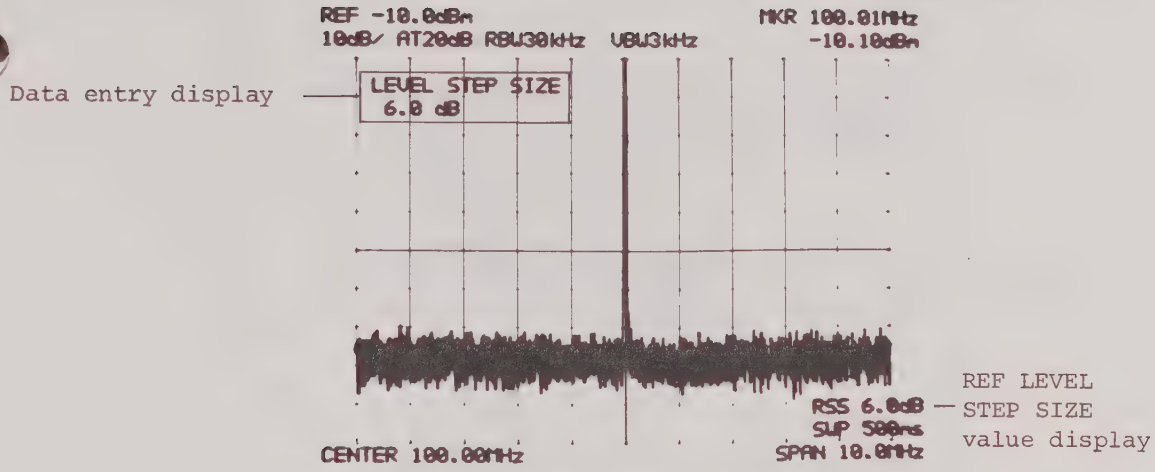


Fig. 3-20 STEP SIZE Setting (2/2)

3.6.7 ENABLED-OFF

- When a function key which enables data entry is pressed, the ENABLED lamp goes on.
- When the OFF key is pressed, the function key setting is released and the data entry display on the screen is cleared.

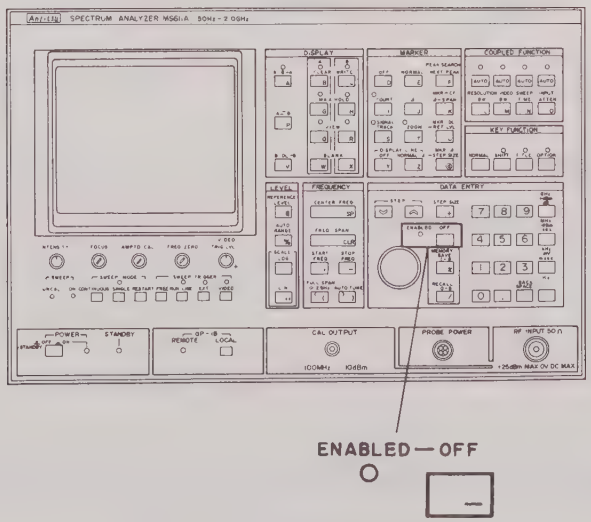


Fig. 3-21 ENABLED-OFF Data Entry

3.7 FREQUENCY

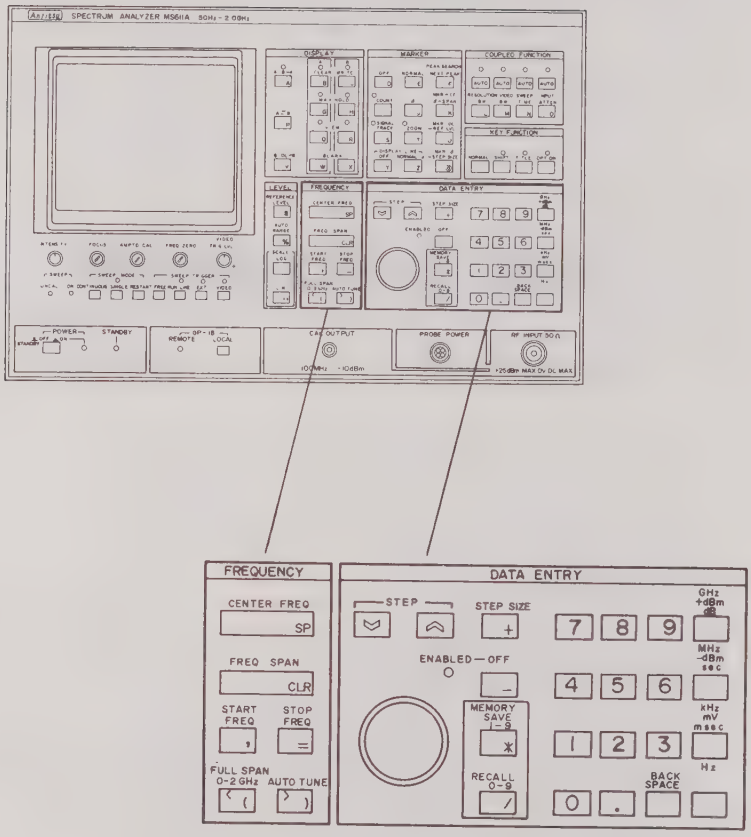


Fig. 3-22 FREQUENCY Setting

3.7.1 CENTER/START/STOP FREQUENCY

(1) The frequency can be set in the following 3 ways:

mode (1) CENTER-SPAN

mode (2) START-SPAN

mode (3) START-STOP

Key action a)

When the CENTER FREQ key is pressed, mode (1) is set.

Key action b)

When the FREQ SPAN key is pressed in mode (1) or (2), the mode does not change. When the FREQ SPAN key is pressed in mode (3), mode (2) is set.

Key action c)

When the START FREQ key is pressed in mode (2) or (3), the mode does not change. When the START FREQ key is pressed in mode (1), mode (2) is set.

Key action d)

When the STOP FREQ key is pressed, mode 3 is set.

(2) The CENTER/START/STOP FREQUENCY entry can be set in the range of 0 to 2.099999999 GHz in units of 1 Hz. However, the value is read (displayed) in units of 1% of the SPAN value. Fractions are not displayed.

However, the low-order digits which are not displayed are valid when the SPAN value is sufficiently less. A data entry can be set by pressing the CENTER FREQ, START FREQ, or STOP FREQ key and when by operating the data knob, the STEP keys, or the number/units keys.

(a) Using the data knob

One turn of the data knob changes a set value by 40 steps. One step size is approximately 0.1% of the current frequency span. The faster the data knob is turned, the greater the number of steps per turn.

(b) Using the STEP keys

When a STEP key is pressed, a set value is changed by one step. One step size is approximately 10% of the current frequency span.

A step size itself can be entered using the number/units keys.

For example, when the CENTER FREQ, STEP SIZE, 1, 0, and MHz keys are pressed, the step size is set to 10 MHz and "FSS 10 MHz" is displayed on the screen. The step size is also available for the start frequency and stop frequency.
The specified step size can be returned to the initial state of the 10% value of the SPAN value by pressing the CENTER FREQ, STEP SIZE, and GHz keys.

(c) Using the number/units keys

A frequency can be set using these keys in units of 1 Hz.

For example, the center frequency can be set to 123.5 MHz by pressing the CENTER FREQ, 1, 2, 3, ., 5, and MHz keys.

If the sweep range is -300 MHz or less or 2.1 GHz or more because of the relationship with the SPAN value, when the CENTER FREQ entry is set "SPAN LIMITED" is displayed, a buzzer sounds, and the SPAN value is automatically limited.

When both a start and stop frequencies are entered, the start frequency must be less than the stop frequency. If an attempt is made to enter a start frequency which is greater than a stop frequency or which is less than a stop frequency by 100 Hz or less, message SET START FREQ < STOP FREQ is displayed.

On the other hand, if an attempt is made to enter a stop frequency which is less than a start frequency or which is greater than a start frequency value by 100 Hz or less, message SET STOP FREQ > START FREQ is displayed.

(3) Using the marker to set the frequency

(a) NORMAL marker mode

When the MKR→CF/Δ→SPAN key is pressed, the frequency at the marker point is set as the center frequency.

(b) " Δ " marker mode

When the MKR→CF/Δ→SPAN key is pressed, the frequencies at the 2 marker points are set as the start frequency and stop frequency. That is, the frequency difference of these 2 marker points is set as the frequency span value.
In this case, the frequency display mode (CENTER-SPAN, etc.) does not change (see section 3.7.1 (1)).

3.7.2 FREQUENCY SPAN

(1) The frequency span value can be set to 0 Hz or in the range 100 Hz to 2.09 GHz. The number of significant digits is 3 digits (100 to 999). For an explanation of FULL SPAN, see section 3.7.3. The frequency span value can be changed or entered by pressing the SPAN key and by using the data knob, STEP keys, or number/units keys.

(a) Using the data knob

One turn of the data knob changes a set value by 40 steps. One step size is approximately 0.1% of the current frequency span value. The faster the data knob is turned, the greater the number of steps per turn.

(b) Using the STEP keys

1-2-5 sequence

(c) Using the number/units keys

A frequency span value can be directly set using 3 significant digits. For example, frequency span 100 kHz can be set by pressing the FREQ SPAN 1, 0, 0, and kHz keys.

(2) Automatic limitation of the FREQUENCY SPAN value

When setting the center frequency or frequency span value, the frequency span value is automatically limited, the buzzer sounds, and "SPAN LIMITED" is displayed on the screen if any of the following cases occurs:

(a) The frequency equivalent to the start frequency (the frequency obtained by subtracting "1/2 x frequency span" from "center frequency") is 300 MHz or less.

(b) The frequency equivalent to the stop frequency (the frequency obtained by adding "1/2 x frequency span" to "center frequency") is 2.1 GHz or greater.

For example, if center frequency 100 MHz is input in the 0-2 GHz FULL SPAN status, the SPAN is changed to 800 MHz.

(3) When the SPAN is set to 0 Hz, RESOLUTION BW, and SWEEP TIME are set to MANUAL mode.

3.7.3 FULL SPAN

When the FULL SPAN key is pressed, each parameter is initialized as follows:

Setting	Contents
START FREQUENCY	0 Hz
STOP FREQUENCY	2.00 GHz
RESOLUTION BW	1 MHz (AUTO)
VIDEO BW	3 MHz (AUTO)
SWEEP TIME	100 ms (AUTO)
INPUT ATTENUATION	10 dB (AUTO)
REFERENCE LEVEL	-10 dBm (103 dBμ when the unit is dBμ.)
DISPLAY	Channel A, CLEAR/WRITE Channel B, BLANK
MARKER	NORMAL 1.000 GHz
SCALE	LOG: 10 dB/div
SWEEP	CONTINUE, FREE RUN

Initialization (INITIAL STATE) after power on is the same as this FULL SPAN setting, except that the level unit is dBm.

3.7.4 AUTO TUNE

When the AUTO TUNE key is pressed, automatic tuning to the maximum-level signal occurs in the range of approximately 20 MHz to 2 GHz. That is, the frequency of the maximum-level signal is set as the center frequency, and the level of this signal is set as the reference level.

The frequency span must be previously set to the desired value. If the frequency span is set to a value greater than 100 MHz, it is set to 100 MHz after the AUTO TUNE operation.

AUTO TUNE can be done for signals which satisfy the following conditions:

- Frequency range: Approx. 20 MHz to 2 GHz
- Level range : Approx. -75 dBm to +25 dBm
- Continuous wave
- Free from exessive frequency and level fluctuation

Note the following conditions on the AUTO TUNE operation:

- The maximum-level point of a signal is displayed at the center of the screen. Therefore, if the side band of a modulated wave has the maximum level of the wave, the center (carrier) frequency is not displayed at the center of the screen.
- When there are two or more signals having the same maximum level, the signal with the lower frequency is selected for AUTO TUNE.
- While the AUTO TUNE routine is being executed, "AUTO TUNE" is displayed on the screen and other key input cannot be done.
- The AUTO TUNE function cannot be executed for FREQUENCY SPAN 0 Hz.

3.8 LEVEL

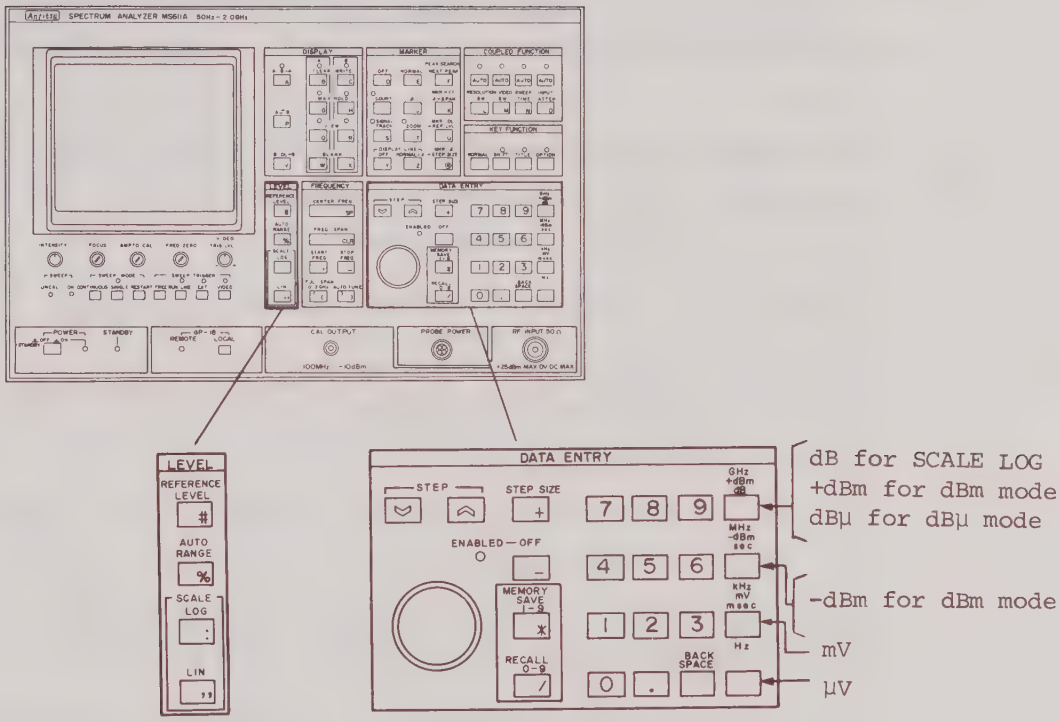


Fig. 3-23 LEVEL Setting

3.8.1 REFERENCE LEVEL

The reference level is the absolute value of the top graticule level. When the peak point of a signal is moved to the top graticule, the reference level indicates the level of the signal.

(1) Units

- Units dBm, dBμ, and Volts (mV or μV) can be used. (1 μV (emf) is assumed to correspond to 0 dBμ. When the SCALE is LOG, either dBm or dBμ can be used and Volts (mV or μV) can be used. However, when the SCALE is LIN, only Volts (mV or μV) can be used. The dBm and -dBm keys cannot be used.

- After POWER ON, dBm mode is set. When dBμ mode is to be used, press the SHIFT and +dBm keys. The subsequent input and display of REFERENCE LEVEL and DISPLAY LINE and the marker display are done in units of dBμ.

  The +dBm key is used as the dBμ unit key. (In this case, the SHIFT key need not be used.) The -dBm key cannot be used for unit dBμ.

  Negative data entry cannot be set when the unit is dBμ.

  The unit mode can be changed from dBμ mode to dBm mode by pressing the SHIFT and +dBm keys again.

- The Volts (mV or μV) unit can be used in both dBm and dBμ modes. Only the mV key or μV key can be used as the unit key. When the value is 1000 mV or greater, it is displayed on the screen in units of Volt.

- When the REFERENCE LEVEL key is pressed, no numeric keys are pressed, and a unit key is pressed, the unit of the level representation on the screen is determined as follows:

  dBm mode

+dBm and -dBm keys	→ dBm representation
mV and μV keys	→ Volts representation

  dBμ mode

+dBm key	→ dBμ representation (The -dBμ key cannot be accepted.
mV and μV keys	→ Volts representation

(2) The REFERENCE LEVEL setting range is -100.0 dBm to +25.0 dBm (13.0 to 138.0 dBμ in dBμ units or 2.262 μV to 3.976 V (setting input 3976 mV) in Volts).
For Volts units also, the value is discrete equivalent to 0.1 dB steps.

Level data can be changed or entered by pressing the REFERENCE LEVEL key and by using the data knob, STEP keys, or number/units keys.

(a) Using the data knob .....

One turn of the data knob changes a set value by 40 steps. One step size is 0.1 dB. The faster the data knob is turned, the greater the number of steps per turn.

(b) Using the STEP keys .....

When a STEP key is pressed, a set value is changed by the following steps:

LOG: 10 dB/div, 5 dB/div: 5 dB step
2 dB/div: 2 dB step
1 dB/div: 1 dB step
LIN: Step equivalent to 5 dB

A step size can be entered using the number/units keys as explained in section 3.6.6.

(c) Using the number/units keys .....

In the dBm or dBμ mode, a value can be set in units of 0.1 dB.

When the mV or μV unit is to be used, a value consisting of 4 significant digits can be input. The input value is converted to a discrete value (0.1 dB step) and set.

If a value greater than +25.0 dBm (138.0 dBμ, or 3976 mV) is entered, +25.0 dBm (138.0 dBμ, or 3.976 V) is set and displayed. (On the screen, the Volt unit is displayed instead of the mV unit.)

If a value less than -100.0 dBm (13.0 dBμ, or 2.262 μV) is entered, -100.0 dBm (13.0 dBμ, or 2.262 μV) is set and displayed.

(3) Using the marker to set the REFERENCE LEVEL

When the MKR/DL → REF LEVEL key is pressed, the marker point level (in NORMAL marker mode) or the active marker point level (in "Δ" marker mode) is set as the REFERENCE LEVEL.

However, if the marker level exceeds +25.0 dBm (+138.0 dBμ, or 3.976 V), the value actually set is +25.0 dBm (+13.0 dBμ, or 3.976 V). On the other hand, if the marker level is less than -100.0 dBm (13.0 dBμ, or 2.262 μV), the value actually set is -100.0 dBm (13.0 dBμ, or 2.262 μV).

(4) Using the DISPLAY LINE to set the reference level

When the SHIFT key and then the MKR/DL → REF LEVEL key are pressed, the NORMAL DISPLAY LINE level or the Δ DISPLAY LINE active line level is set as the reference level.

However, if the DISPLAY LINE level is -100 dBm (13.0 dBμ or 2.262 μV), the value actually set is -100.0 dBm (13.0 dBμ or 2.262 μV).

(5) Relationship between INPUT ATTENUATOR and REFERENCE LEVEL

When the INPUT ATTENUATOR is set in MANUAL mode, the reference level value is limited according to the input attenuator value.

Table 3-5 shows the relationship between the input attenuator and reference level range. If an attempt is made to enter a value exceeding this range, message SET INPUT ATT => 30 dB is displayed.

Table 3-5 Relationship between Input Attenuator and Reference Level Range

Input attenuator (dB)	Reference level range (dBm)*
0	-10.0 ∿ -100.0
5	-5.0 ∿ -95.0
10	0.0 ∿ -90.0
15	5.0 ∿ -85.0
20	10.0 ∿ -80.0
25	15.0 ∿ -75.0
30	20.0 ∿ -70.0
35	25.0 ∿ -65.0
40	25.0 ∿ -60.0
45	25.0 ∿ -55.0
50	25.0 ∿ -50.0
55	25.0 ∿ -45.0

*When the unit is V (mV or μV) or dBμ, a converted value is used.

3.8.2 AUTO RANGE

When the AUTO RANGE key is pressed, the signal with the maximum level in the range of approximately 20 MHz to 2 GHz is searched for, and the INPUT ATTENUATOR is set so that the widest dynamic range is obtained for the signal. In this case, other parameters parameters such as center frequency do not change. Usually, the REFERENCE LEVEL value also does not change, but it is sometimes changed due to limitation by the newly set input attenuator value.

When the AUTO RANGE function is executed, the A-B → A, VIDEO AVERAGING function is released. When the AUTO RANGE function is executed in MARKER OFF state, the MARKER NORMAL state is set.

During AUTO RANGE operations, "AUTO RANGE" is displayed on the screen.

This function is useful for harmonic spurious measurements.

The following is an example of measuring the secondary harmonic wave of a 470 MHz fundamental wave. In this measurement, center frequency of 940 MHz, frequency span of 10 kHz, and resolution bandwidth of 300 Hz are used. In AUTO COUPLED mode, the input attenuator is set so that the widest dynamic range is obtained for the reference level (for the signal having the same level as the reference level). Therefore, if the fundamental wave is not displayed on the screen and the reference level is to be changed for the measurement shown in this example, the input attenuator is not always the optimal value and measurement errors due to internal distortion may occur.

To prevent this from occurring, press the AUTO RANGE key. The level of the fundamental wave is then searched and the optimal input attenuator value is set for the level. Therefore, in this case, measurement errors due to internal distortion need not be considered.

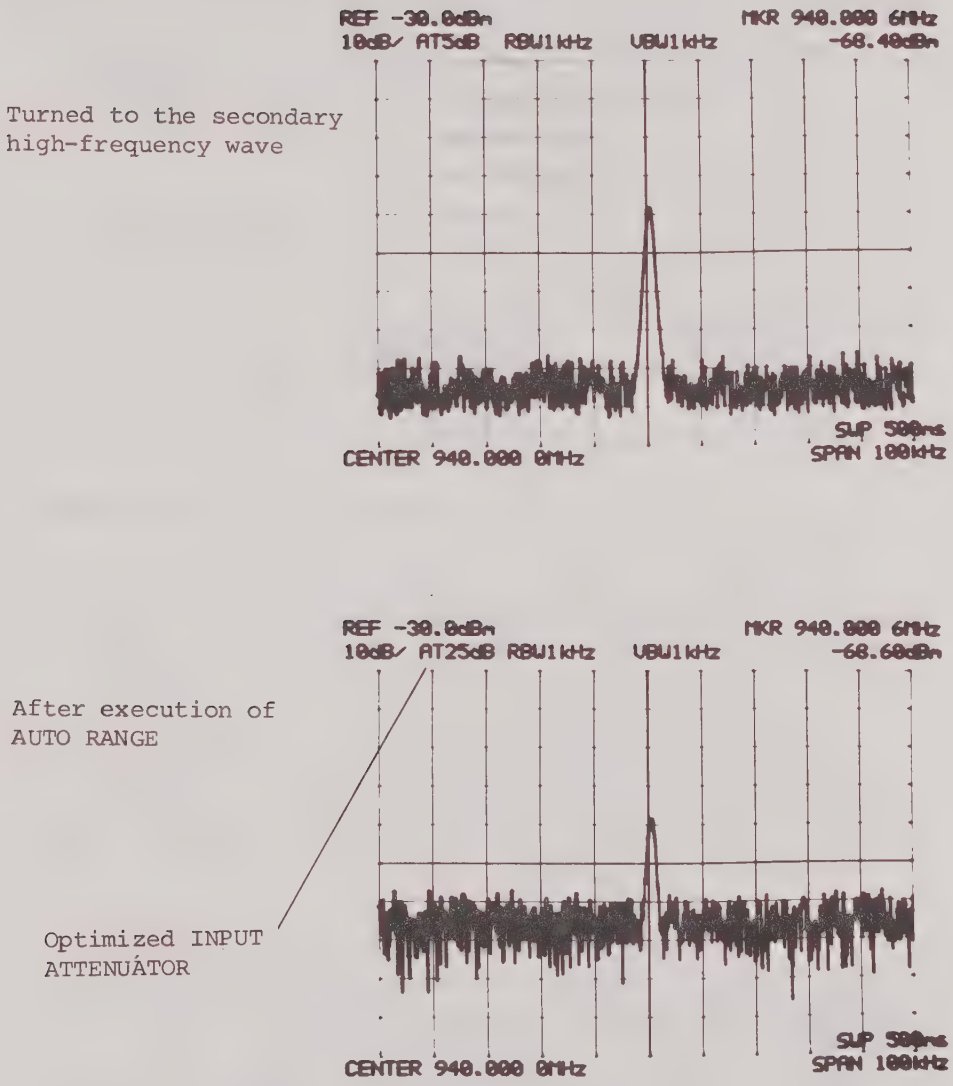


Fig. 3-24 AUTO RANGE Display

3.8.3 SCALE LOG/LIN

The SCALE can be set to LOG 10 dB/div, LOG 5 dB/div, LOG 2 dB/div, LOG 1 dB/div, or LIN.

A LOG scale can be set by pressing the LOG key and by using the STEP or number/units keys.

(a) Using the data knob

In this case, the data knob cannot be used.

(b) Using the STEP keys

1, 2, 5, and 10 can be sequentially set.

(c) Using the number/units keys

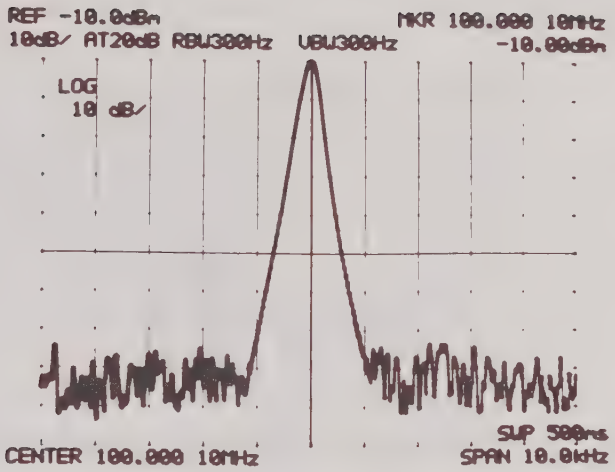
A LOG scale can be directly input using these keys.

For example, LOG 5 dB/div can be set by pressing the LOG, 5, and dB keys. If the 3 or 4 key and the dB key are pressed, 5 dB is assumed. If the 6 to 9 or 11 or a greater number is input and the dB key is pressed, 10 dB is assumed. When only the LOG and dB keys are pressed, LOG 10 dB/div is assumed.

The LIN scale can be set by only pressing the LIN key. When the LIN scale is used, the reference level is represented in volts.

When the LOG key is pressed in LIN mode, LOG 10 dB/div is set.

LOG 10 dB/div



LIN

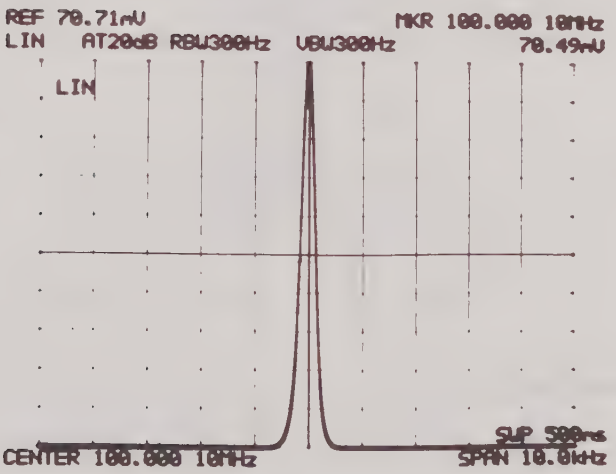


Fig. 3-25 SCALE Range Display

3.9 DISPLAY

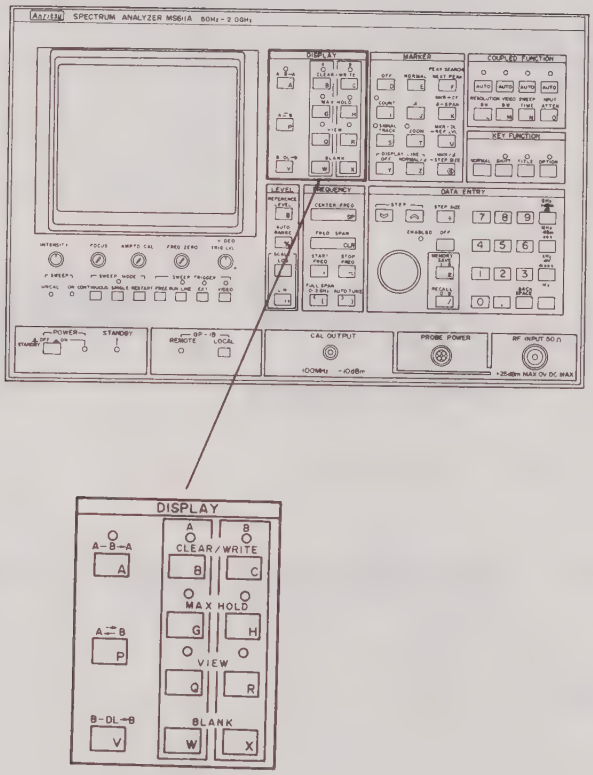


Fig. 3-26 DISPLAY Setting

3.9.1 DISPLAY Mode

The MS611A contains a two-channel (A and B) digital storage memory. Both channels A and B can be displayed at the same time. Each channel has the following four display modes:

- o CLEAR/WRITE mode

  When the CLEAR/WRITE key is pressed, the corresponding LED goes on, the memory contents are cleared, and a spectrum of the next sweep is written and displayed. Each time a sweep is done, the newest data is rewritten.

When both channels A and B are in CLEAR/WRITE mode, data is rewritten alternately at each sweep and also displayed.

- MAX HOLD mode

  When the MAX HOLD key is pressed, the corresponding LED goes on and the memory contents are rewritten at each sweep. At this time, the previous data and the new data are compared at each X-axis point, and the data with the higher value is selected and written to memory.

  Note that channels A and B cannot be set to MAX HOLD mode at the same time.

  When channel B (channel A) is set to MAX HOLD mode while channel A (channel B) is in MAX HOLD mode, channel A (channel B) is set to VIEW mode.

- VIEW mode

  When the VIEW key is pressed, the corresponding LED goes on and the memory contents are displayed, but the memory contents are not rewritten.

- BLANK mode

  When the BLANK key is pressed, the memory contents are not displayed, not rewritten, but are retained.

Note: When one channel is displayed on the screen, the marker is displayed for that channel. When two channels are displayed at the same time, the marker is displayed for the channel for which the DISPLAY mode key was last pressed.
When both channels are in BLANK mode, no marker is displayed.

3.9.2 Arithmetic Functions

(1) A - B → A

When the A - B → A key is pressed, the channel B contents are subtracted from the channel A contents, and the result is set in channel A memory. The reference value of the subtraction results changes depending on the reference line value of Δ DISPLAY LINE. When channel A is in CLEAR/WRITE mode, the subtractions are done concurrently with the sweep. If channel B had previously been set to BLANK mode, channel B remains in BLANK mode.

On the other hand, if channel B is in another mode, channel B is set to VIEW mode.
When the A - B → A key is pressed again, this function is released.

Note: The A - B → A key cannot be used during VIDEO AVERAGING.

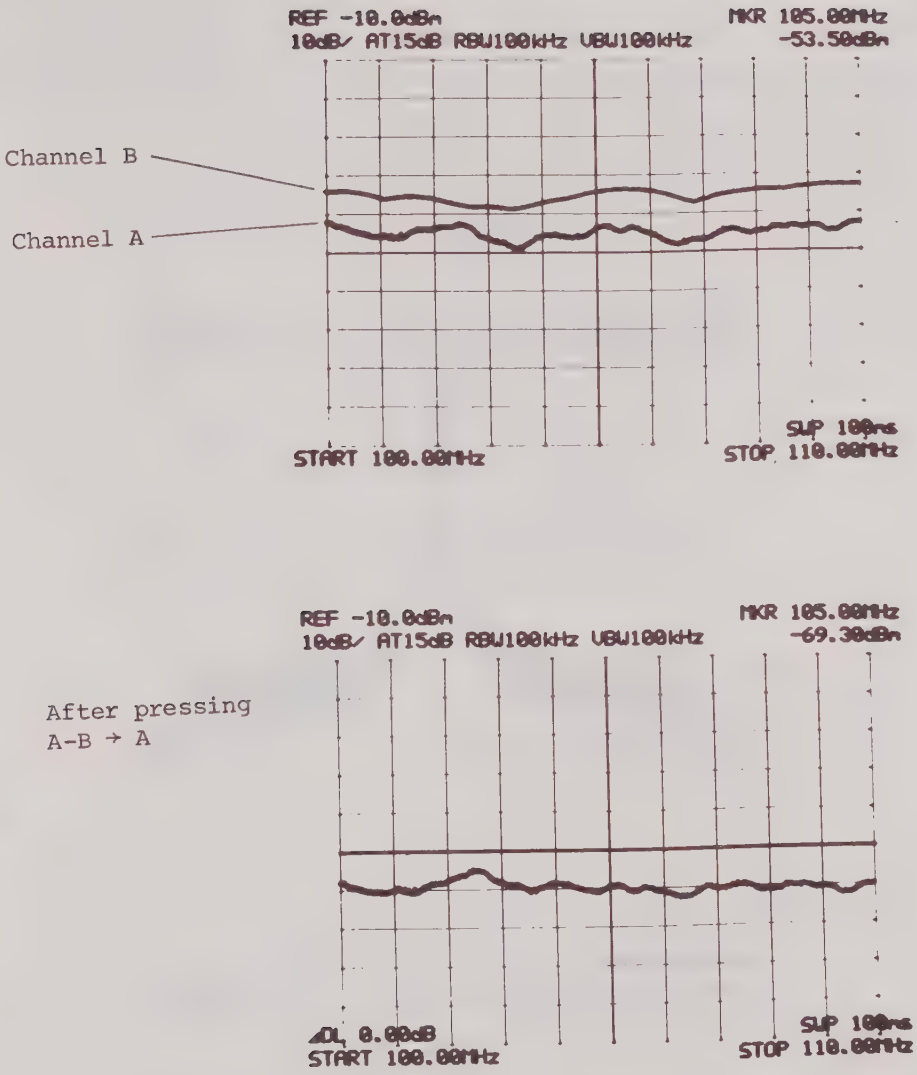


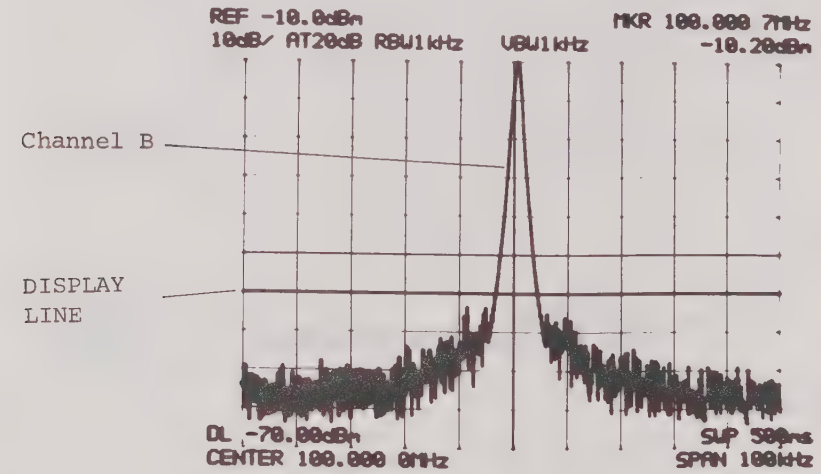
Fig. 3-27 A - B → A Display

(2) A ⇄ B

When the A ⇄ B key is pressed, the channel A contents and the channel B contents are interchanged.
In this case, the DISPLAY mode of channels A and B does not change.

(3) B - DL → B

When the B - DL → B key is pressed, the display line value is subtracted from the channel B contents, and the result is set into channel B memory.
Channel B is set to VIEW mode.
This key cannot be used during DISPLAY LINE OFF.



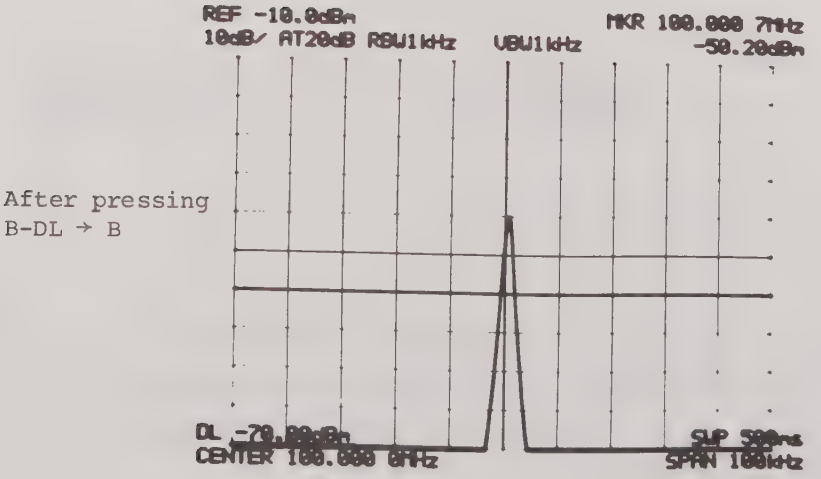


Fig. 3-28 B - DL → B Display

3.10 MARKER

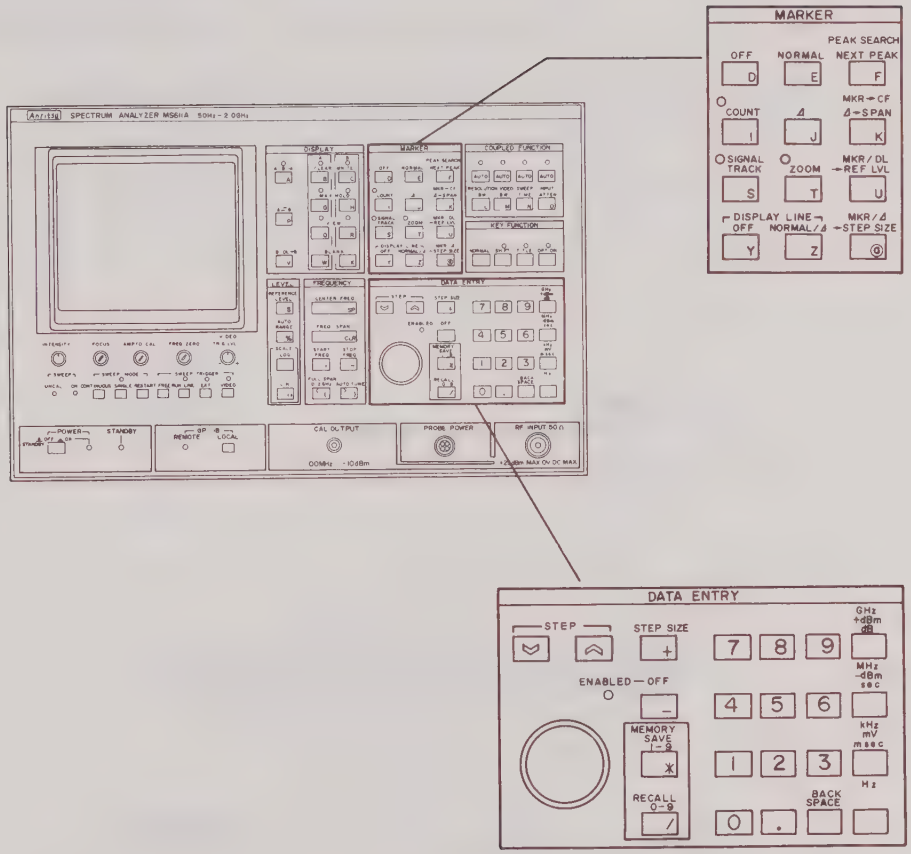


Fig. 3-29 MARKER Display

3.10.1 NORMAL MARKER

When the MARKER NORMAL key is pressed, one marker is displayed on the trace. In this case, when both channels A and B are displayed at the same time, the marker is displayed for the channel for which the DISPLAY mode key was last pressed.

The displayed marker position can be moved using the data knob, STEP keys, or number/units keys.

A marker point is displayed for the measurement on the screen. Therefore, if the displayed channel or specified frequency is changed, the relative position on the horizontal axis does not change. The level, that is, the position on the vertical axis, is determined according to the displayed trace.

When the frequency span is 0 Hz (for time domain), the marker indicates the time from the leftmost graticule line.

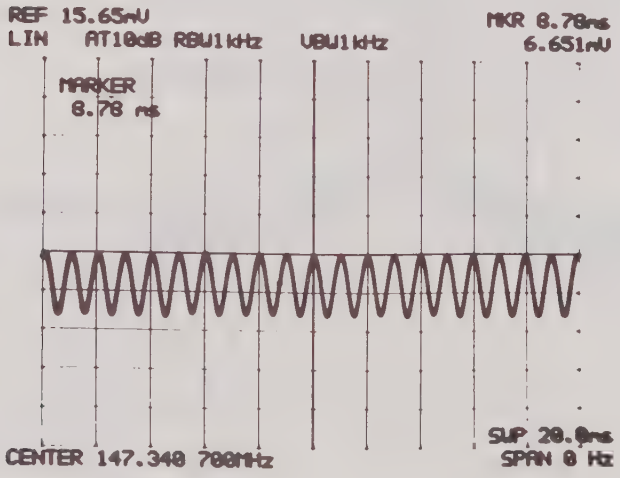


Fig. 3-30 NORMAL MARKER Display

After the NORMAL key is pressed, the marker point frequency can be changed or entered using the data knob, STEP keys, or number/units keys.

(a) Using the data knob

One turn of the data knob moves the set value by 40 steps. One step is 1/100 div. The faster the data knob is turned, the greater the number of steps per turn.

(b) Using the STEP keys

One step is 1 div.

(c) Using the number/units keys

The frequency of marker point can be directly input in units of 0.1 Hz by using these keys. However, the entered value is displayed in units of 0.1% of the span.
When the frequency span is 0 Hz, time is represented and input using the number/units keys cannot be done.

- If the marker display position is outside the screen area, the marker is displayed at the left or right end of the screen.
- The marker-point frequency display resolution is 0.1% of the frequency span (1/100 div).
- The marker-point level display resolution is the 0.1% of vertical-axis full scale (for example, 0.1 dB at LOG 10 dB/div or 0.01 dB at LOG 1 dB/div).
- For SCALE LOG 10 dB/div, the calibrated range of the level displayed is from the reference level to -90 dB, but a marker level up to -100 dB can be displayed. (For example, when the reference level is -10 dBm and the marker point is located on the bottom graticule line, marker level -110 dBm is displayed.) Note that the range from -90 dB to -100 dB is not calibrated.
- When the NORMAL key is pressed in "Δ" marker mode, the active marker remains but the reference marker is deleted.

3.10.2 Δ (Delta) MARKER

There are two ΔMARKER modes: ordinary ΔMARKER mode (set by the Δ key) and ΔMARKER ON SCREEN mode (set by the SHIFT and Δ keys). In each mode, two marker points are displayed, but the meaning of the reference marker is different.

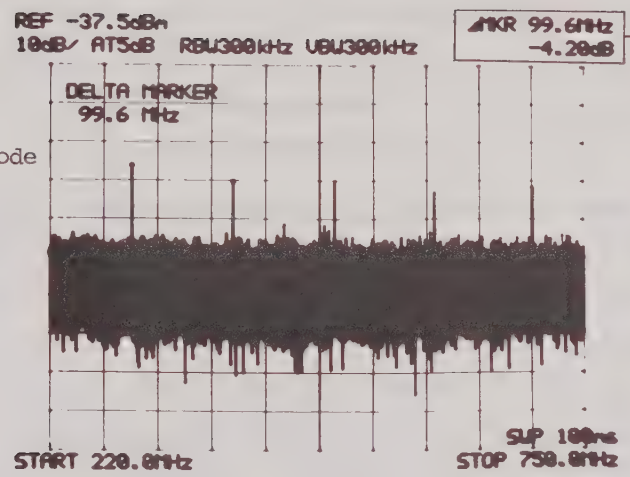
(1) Ordinary Δ MARKER

When the MARKER Δ key is pressed, two markers are displayed on the trace. In this case, when both channels A and B are displayed at the same time, the markers are displayed for the channel for which the DISPLAY mode key was last pressed.

One marker is the reference marker. When the Δ key is pressed in NORMAL marker mode, the current marker is set as the reference marker, and the frequency and level of this marker is stored in memory.

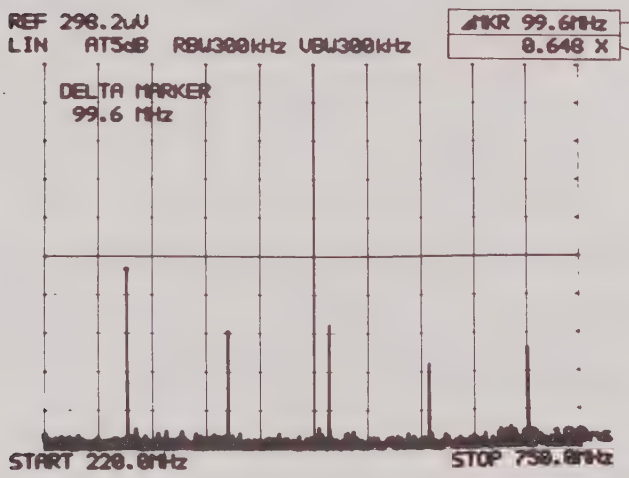
The other marker is the active marker. When the Δ key is pressed in NORMAL marker mode, the active marker and the reference marker are located at the same position. The position of the active marker can be changed using the data knob, STEP keys, or number/units keys. The frequency and level differences between these markers are displayed at the upper right of the screen.

These values are represented in dB (for SCALE LOG) or in magnification power (x) (for SCALE LIN).
When the frequency span is 0 Hz, the time and level differences are displayed.



Display of the frequency and level differences between two markers

LOG 10 dB/div mode



Frequency difference

Magnification power

LIN mode

Fig. 3-31 ΔMARKER Display

The data of the active marker can be set by pressing the Δ key and by using the data knob, STEP keys, or number/units keys.

(a) Using the data knob

One turn of the data knob moves the set value by 40 steps. One step is 1/100 div. The faster the data knob is turned, the greater the number of steps per turn.

(b) Using the STEP keys

One step is 1 div.

(c) Using the number/units keys

The frequency difference can be entered in units of 0.1 Hz. The entered data is displayed in units of 0.1% of the span.
When the active marker is to be moved to the left of the reference marker (that is, when the frequency of the active marker is to be lower than that of the reference marker), a negative frequency can be entered.

For example, -100 kHz can be entered by pressing the SHIFT, ENABLED-OFF 1, 0, 0, and kHz keys.
When the frequency span is 0 Hz, the time is displayed and input using the number/units keys cannot be done.

- The reference marker can be set to a position by moving the active marker to the position, pressing the NORMAL key (to delete the current reference marker), and pressing the Δ key.
- The reference marker point is displayed on the trace. Therefore, variations in the trace change the level, but not change the stored reference level.
- When the Δ marker mode was used before MARKER OFF state, the following occurs:
  - If "Δ" marker mode was used before MARKER OFF state, the previous reference marker and active marker are displayed again.

- If NORMAL marker mode was used before MARKER OFF state, the "Δ" marker is displayed by assuming the previous marker point as the reference marker point.

o If the set position of the active marker is outside the screen area, the marker is displayed at the left or right end of the screen.

o If the position of the reference marker is moved outside of the screen area by changing the center frequency, etc., the reference marker is displayed at the left or right end of the screen. However, the stored reference frequency does not change.

o The display resolution of the frequency difference is 0.1% of the frequency span (1/100 div).

o The display resolution of the level difference is 0.1% of the vertical-axis full scale (for example, 0.1 dB is LOG 10 dB/div or 0.01 dB in LOG 1 dB/div). When the scale is in LIN mode, the magnification power is represented as follows:

- When the magnification power is less than 1, it is represented using 3 digits below the decimal point.

- When the magnification power is 1 or greater, it is represented using 4 significant digits.

When the reference marker is at 0 V (at bottom graticule line), "***" is displayed in the magnification power field.

(2) Δ MARKER ON SCREEN

When the SHIFT and Δ keys are pressed in NORMAL marker mode, the current marker is set as the reference marker, and the frequency and level differences between the active marker and the reference marker existing on the trace are displayed.
Therefore, if the trace changes, the reference marker level also changes. The "Δ MARKER ON SCREEN" mode is useful to measure the signal level difference as the levels of two signals vary as time passes.

When the frequency span is 0 Hz, the time and level differences between two points on the trace are displayed.

Data of the active marker can be set in the same way as in ordinary Δ MARKER mode. See section 3.10.2 (1).

Even if the entered frequency is changed, the reference marker and active marker positions on the horizontal axis on the screen remain the same.

3.10.3 COUNT

When the COUNT key is pressed, the COUNT LED goes on and the frequency of the signal at which the marker point is set is counted and displayed on the screen. The COUNT key can only be used when a sweep operation is being done. After a sweep is completed and before the next sweep starts, the signal frequency is counted with resolution 1 Hz at 1-sec. gate time.

Note the following when in COUNT mode:

- The resolution bandwidth must be set to at least 5% of the frequency span.
  If it is less than 5% in AUTO mode, manually set the resolution bandwidth.

- When an FM wave is to be measured, a fully wide resolution bandwidth should be set to cover the side band. In this case, the carrier frequency (average frequency) can be counted.
- Only continuous-wave signals can be measured.
- The level of the object signal must be at least 20 dB higher than the noise level. Moreover, the dip compared with the adjacent signal must be 20 dB or larger.
- Even if the marker is not located exactly at the signal peak point, the signal frequency can be counted. However, the marker should be located at the signal peak point by using the PEAK SEARCH key or data knob.
- When the MARKER OFF key, NORMAL key, Δ key or SHIFT Δ key is pressed, the COUNT mode is released.
- When either MARKER OFF or NORMAL key is pressed, the COUNT mode is released.
- When the MARKER function is OFF or the DISPLAY mode is other than CLEAR/WRITE, the COUNT key cannot be used.
  When both channels A and B are in CLEAR/WRITE mode, channel B is set to BLANK mode.
  When one channel is in CLEAR/WRITE mode and the other channel is in MAX HOLD or VIEW mode, the second channel is set to BLANK mode.
- When the COUNT key is pressed in "Δ" marker mode, the active marker remains but the reference marker is erased, and the NORMAL marker mode is set.
- During COUNT mode, the DISPLAY MODE key cannot be used for the active marker.

3.10.4 SIGNAL TRACK

When the SIGNAL TRACK key is pressed during marker display, the SIGNAL TRACK LED goes on and the center frequency is adjusted to the displayed signal. The SIGNAL TRACK function can be executed only when sweep is being done.

At each sweep, the displayed peak point is searched and the center frequency is automatically changed so that the signal is displayed at the center of the screen.

Therefore, even if the signal frequency drifts, the signal is always displayed at the center of the screen.

- When the MARKER OFF key, NORMAL key, Δ key or SHIFT Δ key is pressed, the SIGNAL TRACK mode is released. Also, when the DISPLAY CLEAR/WRITE, MAX HOLD, VIEW or BLANK key is pressed, the SIGNAL TRACK mode is released.
- When the MARKER function is OFF or the DISPLAY mode is other than CLEAR/WRITE, the SIGNAL TRACK key cannot be used.
  When both channels A and B are in CLEAR/WRITE mode, channel B is set to BLANK mode.
  When one channel is in CLEAR/WRITE mode and the other channel is in MAX HOLD or VIEW mode, the second channel is set to BLANK mode.
- When the SIGNAL TRACK key is pressed in "Δ" marker mode, the active marker remains but the reference marker is erased, and the NORMAL marker mode is set.
- When the frequency span or another frequency setting is changed in SIGNAL TRACK mode, the noise caused by this operation may be displayed on the screen and the desired signal may not be able to be traced.

In this case, the center frequency must be set to an appropriate value.
However, when the frequency span is changed in ZOOM mode, actual change occurs after the sweep ends. Therefore, tracking in this case is not influenced by noise caused by the change.

- When the frequency span is 0 Hz, the SIGNAL TRACK key cannot be used.
  When the frequency span is set to 0 Hz in SIGNAL TRACK mode, SIGNAL TRACK mode is released.

3.10.5 ZOOM

When the ZOOM key is pressed while the marker is displayed, the ZOOM LED goes on and the data entry knob/keys can be used as follows:

(a) Data knob

Moves the marker point to the right or left.

(b) STEP keys

Change the frequency span in 1-2-5 sequence.

(c) Number/units keys

Directly set the frequency span.

When a STEP key or number/units key is pressed, the frequency at the marker point is set as the center frequency. The following is an example of ZOOM:

(1) Press the ZOOM key.

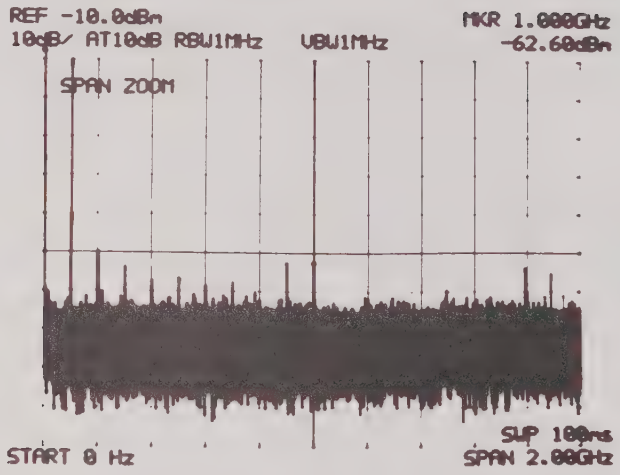


Fig. 3-32 ZOOM Display

(2) Set the marker to the desired signal by using the data knob.

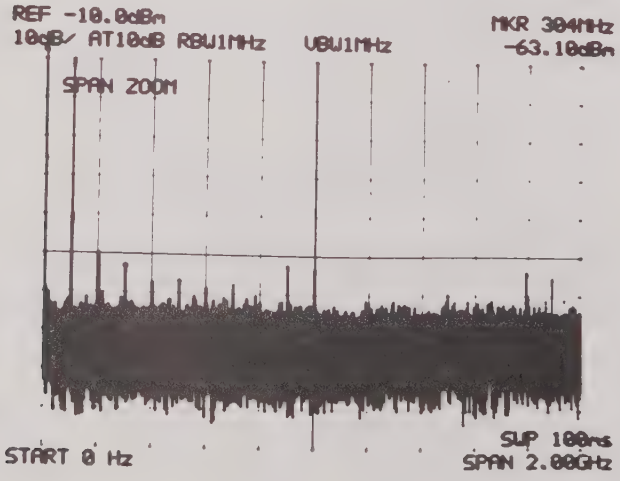


Fig. 3-32 ZOOM Display (Cont'd)

(3) Press the STEP key ⩒ twice. The frequency span is narrowed by two steps.

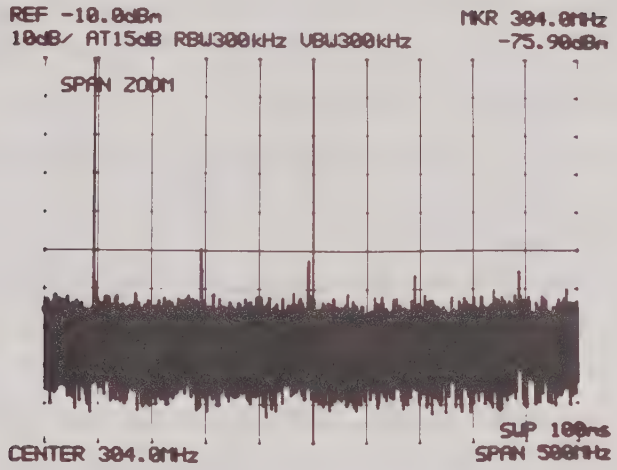


Fig. 3-33 ZOOM Display (Cont'd)

(4) Set the marker to the desired signal and press the STEP key ⩒ .

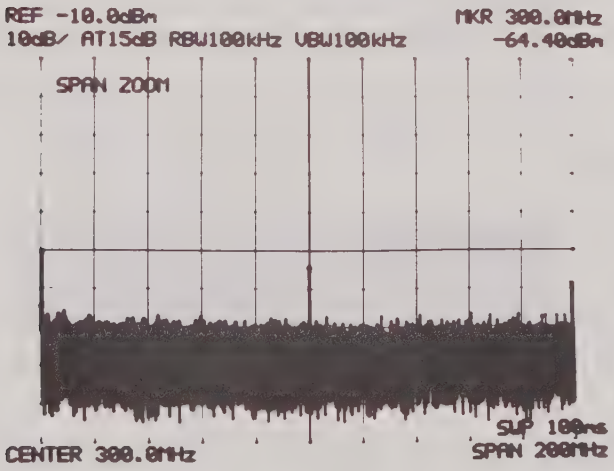


Fig. 3-33 ZOOM Display (Cont'd)

As shown above, the ZOOM function is useful for tuning when part of a signal is to be enlarged and measured.

- When the MARKER OFF key, the NORMAL key, or the Δ key is pressed or when the SHIFT and Δ keys are pressed, ZOOM mode is released.
- When the SIGNAL TRACK mode is set together with ZOOM mode, the maximum-level signal on the screen is displayed at the center of the screen at each sweep. Therefore, when changing of the frequency span is specified using the STEP keys or number/units keys, the frequency span is changed while the signal is displayed at the center of the screen.
- In this case, the frequency span is not changed during sweeping, but occurs together with the SIGNAL TRACK operation (the peak is searched for and the detected frequency is set as the center frequency) after the sweep ends.

3.10.6 PEAK SEARCH functions

In the marker-display trace (including VIEW mode), there are six functions to set a marker to a peak point (in "Δ" marker mode, the active marker is set) as follows:

(1) PEAK SEARCH

When the PEAK SEARCH key is pressed, the marker is set to the maximum-level point in the entire trace. (When there are two or more points having the same level, the marker is set to the leftmost one.)

(2) NEXT PEAK

When the SHIFT and PEAK SEARCH keys are pressed, the marker is set to a peak point whose level is the next higher as compared with the peak point at which the marker is currently set.

When the SHIFT and PEAK SEARCH keys are sequentially pressed, the marker sequentially moves to the next peak points. This movement can be repeated up to ten times. If the SHIFT and PEAK SEARCH key are pressed again over ten times, "FINISH" is displayed and the marker does not move. If there is no next-higher peak point when the SHIFT and PEAK SEARCH keys are pressed, "NO NEXT" is displayed.

When the PEAK SEARCH key is pressed, the screen displays the following data:

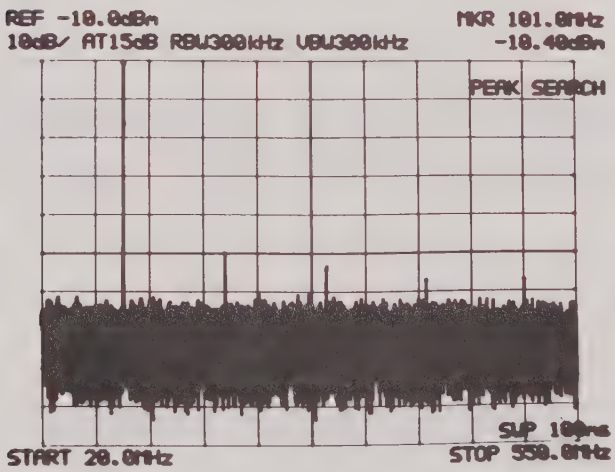


Fig. 3-34 PEAK SEARCH Display

When the SHIFT and PEAK SEARCH keys are pressed, the screen displays the following data:

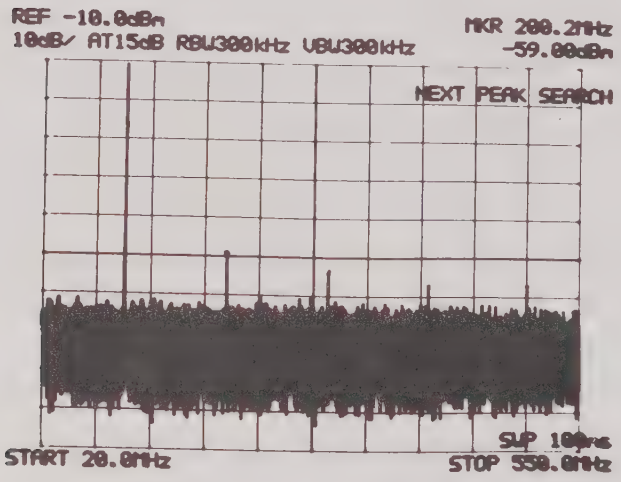


Fig. 3-35 SHIFT, PEAK SEARCH Display

(3) LEFT PEAK SEARCH

When the SHIFT and COUNT keys are pressed, the marker is set to the maximum-level point in the range from the left end to the third graticule line (3 divisions) on the trace on which the marker is currently set.

(4) CENTER PEAK SEARCH

When the SHIFT and ZOOM keys are pressed, the marker is set to the maximum-level point in the range of 4 divisions at the center of the trace on which the marker is currently set.

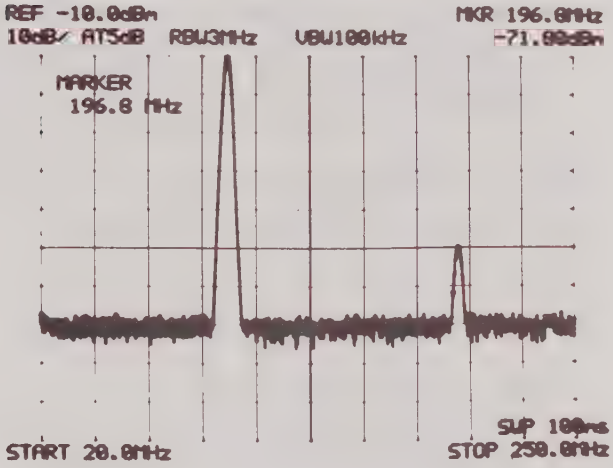
(5) RIGHT PEAK SEARCH

When the SHIFT and MKR→CF/Δ→SPAN keys are pressed, the marker is set to the maximum-level point in the range from the right end to the third graticule line (3 divisions) on the trace on which the marker is currently set.

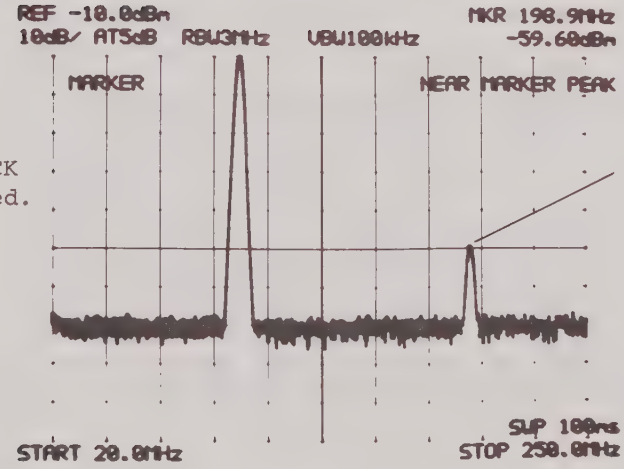
(6) NEAR MARKER PEAK SEARCH

When the SHIFT and SIGNAL TRACK keys are pressed, the marker is set to a peak point of the signal on which the marker is currently set.

The marker is being set on signal, but is not being set at the peak point of the signal.



When the SHIFT and SIGNAL TRACK keys are pressed.



The marker is set to the peak point of this signal.

Fig. 3-36 SHIFT, SIGNAL TRACK Display

3.10.7 Marker Entry Functions

The frequency and level at a marker point can be used as entry data, by using the 5 functions shown in Table 3-6.

Table 3-6 Marker Entry Functions

MKR → CF	Sets the CENTER FREQUENCY equal to the marker point frequency in [NORMAL] marker mode.	Same key
Δ → SPAN	Sets the frequency span equal to the marker point frequency difference in [Δ] marker mode. Sets the frequencies of the 2 marker points in this mode as the START FREQUENCY and the STOP FREQUENCY, respectively.	
MKR → REF LVL	Sets the REFERENCE LEVEL equal to the marker level in [NORMAL] marker mode or the active marker level in [Δ] marker mode.	
MKR → STEP SIZE	Sets the STEP SIZE of the CENTER, START, or STOP FREQUENCY equal to the marker point frequency in [NORMAL] marker mode.	Same key
Δ → STEP SIZE	Sets the STEP SIZE of the CENTER, START, or STOP FREQUENCY equal to the marker point frequency difference in [Δ] marker mode.	

3.10.8 DISPLAY LINE

(1) NORMAL DISPLAY LINE

When the DISPLAY LINE NORMAL key is pressed, one horizontal line is displayed on the screen and its level can be adjusted.

After the NORMAL key is pressed, level data can be entered using the data knob, STEP keys, or number/units keys.

(a) Using the data knob

One turn of the data knob moves the set value by 40 steps. One step is 1/100 div. The faster the data knob is turned, the greater the number of steps per turn.

(b) Using the STEP keys

One step is 1 div.

(c) Using the number/units keys

When the scale is LOG, data can be set in units of 0.1 dB. The setting range is -100.0 dBm to +25 dBm (or 13.0 to 138.0 dBμ) can be entered using these keys. Units can be used ones of REFERENCE LEVEL. Values represented in V units cannot be entered.
When the scale is LIN, data cannot be entered using the number/units keys.

- If the display line is to be set outside the screen area, it is displayed at the top or bottom graticule line.

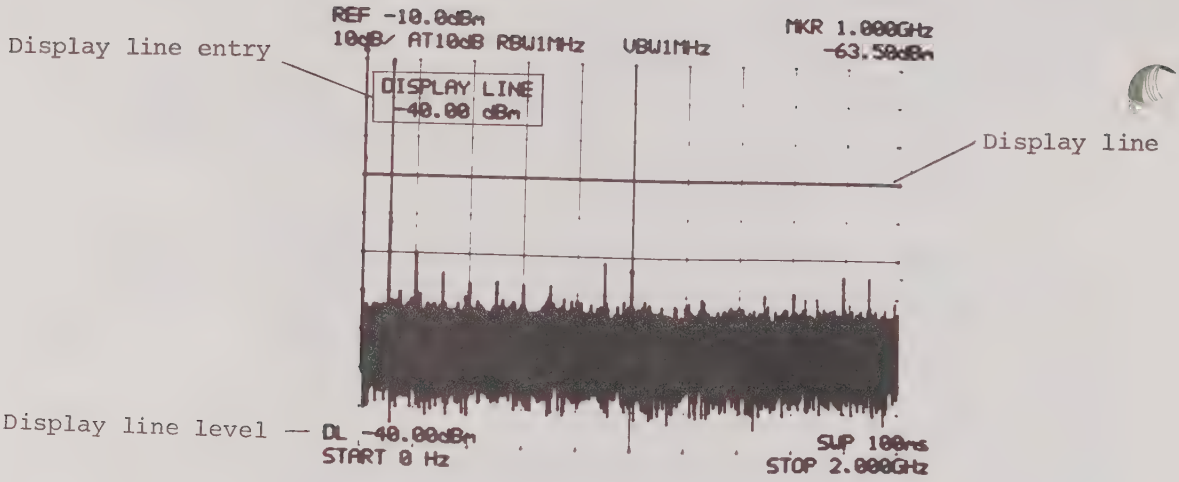


Fig. 3-37 DISPLAY LINE entry

- For SCALE LOG 10 dB/div, the level display calibration range is from the REFERENCE LEVEL to -90 dB, but a DISPLAY LINE level up to -100 dB can be displayed. For example, when the REFERENCE LEVEL is -10 dBm and the display line is located at the bottom graticule line, -110 dBm is displayed. Note that the range from -90 to -100 dB is not being calibrated.

(2) Δ(delta) DISPLAY LINE

When the SHIFT key and the DISPLAY LINE NORMAL key are pressed, two horizontal lines are displayed on the screen.

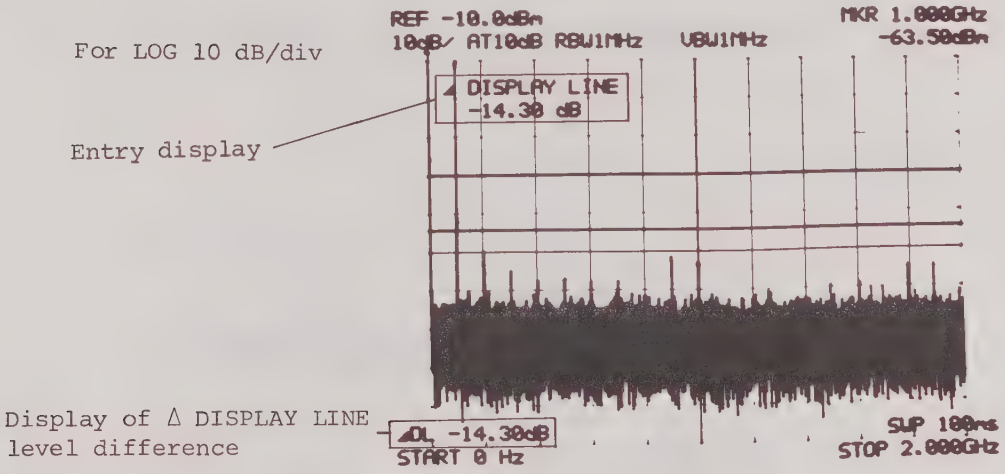
One line is the reference line. When ΔDISPLAY LINE mode is set from NORMAL DISPLAY LINE mode, the line which was displayed in the NORMAL DISPLAY LINE is set as the reference line.

The other line is the active line. When Δ DISPLAY LINE mode is set, the active line is located at the same position as the reference line position. The position

of the active line can be changed using the data knob or STEP keys.

The level difference between these two lines is displayed at the lower left of the screen.

When the scale is LOG the level difference is displayed in dB. When the scale is LIN the level difference is displayed using a magnification power (x).



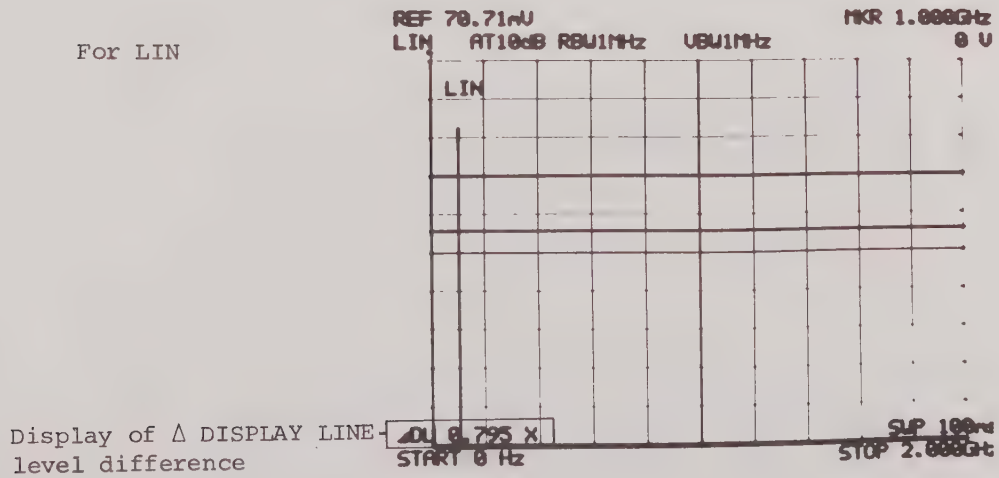


Fig. 3-38 Δ DISPLAY LINE entry

The active line data can be set by pressing the SHIFT and DISPLAY LINE NORMAL keys and by using the data knob or STEP keys.

(a) Using the data knob

One turn of the data knob changes the set data by 40 steps. One step is 1/100 div. The faster the data knob is turned, the greater the number of steps per turn.

(b) Using the STEP keys

One step is 1 div.

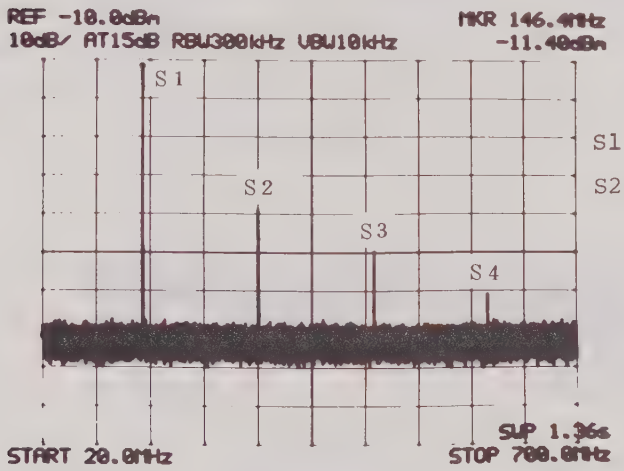
(c) Using the number/units keys

The number/units keys cannot be used for this purpose.

3.10.9 Using the Marker Functions Effectively

The marker functions make measurements simpler and easier to do.

(1) Measuring the level difference between the fundamental wave and spurious signal which are displayed on the screen at the same time (combination of Δ MARKER with NEXT PEAK).



S1: Fundamental wave

S2, S3, S4: Spurious components

Fig. 3-39 Initial Display of MARKER function

[Procedure]

(1) Press the MARKER NORMAL key and then the PEAK SEARCH key. The marker moves to the peak point of fundamental wave S1, and the frequency and level of the marker are displayed.

(2) Press the Δ key.

(3) Press the SHIFT and PEAK SEARCH (NEXT PEAK) keys. The marker moves to the next-level spurious signal (S2), and the level difference from the fundamental wave is displayed.

④ Repeatedly press the SHIFT and PEAK SEARCH (NEXT PEAK) keys. The marker sequentially moves to the next-level signals, and the level differences from the fundamental wave are sequentially displayed.

(2) Measuring low-level harmonic spurious (use of MKR → STEP SIZE)

To measure a low-level spurious component, the resolution bandwidth (RESOLUTION BW) must be narrowed and the noise level reduced. The measurement time can be shortened by tuning to the frequency of the harmonic and by narrowing the frequency span.

[Procedure]

① Set the RESOLUTION BW and the frequency span.

② Press the AUTO TUNE key. Tuning to the fundamental wave is done.

③ Press the MKR → STEP SIZE key. The frequency of the fundamental wave is set as the frequency step size.

④ Press the MARKER Δ key.

⑤ Press the CENTER FREQ and ⩓ keys. The frequency of the secondary harmonic is set as the center frequency.

⑥ Press the PEAK SEARCH key. The active marker moves to the peak point of the secondary harmonic component, and the level difference is Δ MARKER mode is set as the level difference from the fundamental wave.

⑦ Press the CENTER FREQ and ⩓ keys. The frequency of the third harmonic is set as the center frequency.

As explained above, sequential turning to harmonic components can be done using the STEP KEY ⩓ .

(3) Selecting one signal from many signals, and enlarging it at the center of the screen (combination of ZOOM with SIGNAL TRACK).

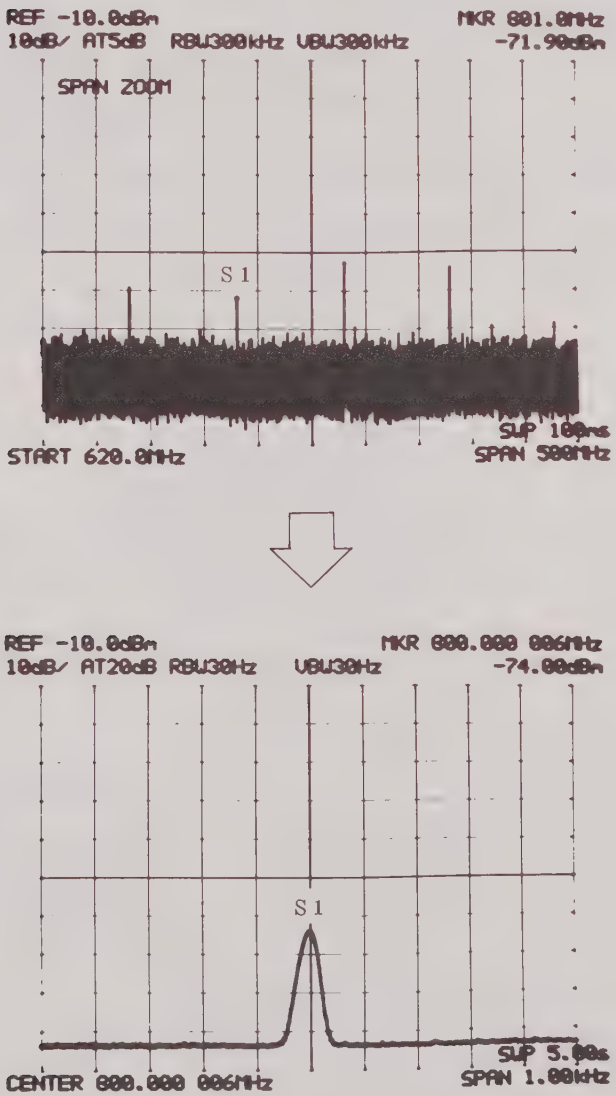


Fig. 3-40 MARKER Function Display

[Procedure]

(1) Press the MARKER NORMAL key, and move the marker to the object signal (S1) using the data knob.

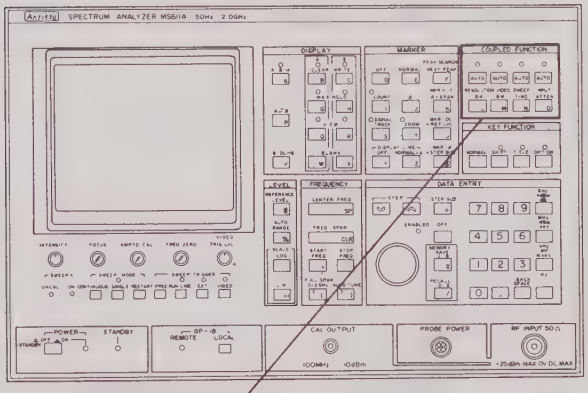
(2) Press the ZOOM key and the STEP key ⩒ . The frequency span is narrowed one step centering around S1.

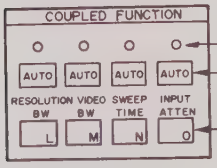
(3) Adjust the marker to the object signal, and press the STEP ⩒ key.
When the object signal is the maximum-level signal displayed on the screen, press the SIGNAL TRACK and FREQ SPAN keys, and input the object frequency span by using the number/units keys. The object signal is enlarged at the center of the screen (at the object frequency span).

3.11 COUPLED FUNCTION

Coupled function can be executed using the RESOLUTION BW, VIDEO BW, SWEEP TIME, and INPUT ATTEN keys. When one of these keys is pressed, the necessary data can be input using the STEP keys, etc. Coupled functions can also be executed using the AUTO keys (AUTO COUPLED mode). When an AUTO key is pressed and the frequency span or the reference level is changed, the value corresponding to the pressed AUTO key is automatically set so that no error occurs in the frequency or level measurement.

AUTO COUPLED mode is set by turning power on or by pressing the FULL SPAN key or an AUTO key.





These LEDs go on when AUTO COUPLED mode is set.

These keys set AUTO COUPLED mode. The preset value which varies corresponding to the FREQ SPAN or REFERENCE LEVEL value is set for each value.

The values entered using these functions do not vary (entry mode). These values can be set using the data knob (only or setting a sweep time), STEP keys, or numeric and unit keys.

Fig. 3-41 COUPLED FUNCTION Setting

- When AUTO COUPLED mode is used for RESOLUTION BW, the resolution bandwidth is set according to the FREQUENCY SPAN. (See Table 3-7)
- When AUTO COUPLED mode is used for VIDEO BW, the one step higher value than the RESOLUTION BW is set as the video bandwidth.
- When AUTO COUPLED mode is used for SWEEP TIME, the sweep time is set according to the FREQUENCY SPAN, RESOLUTION BW, and VIDEO BW values (see Table 3-7).
- When AUTO COUPLED mode is used for INPUT ATTENUATOR the input attenuator is set according to the REFERENCE LEVEL and RESOLUTION BW.
- When the FREQUENCY SPAN is 0 Hz, the RESOLUTION BW and SWEEP TIME functions are executed in manual entry mode.

Table 3-7 Relationship between Frequency Span, Resolution Bandwidth, and Sweep Time

Frequency Span (Hz)	Resolution Bandwidth (Hz)	Sweep Time
100 ∿ 200	10	5 ∿ 10S
201 ∿ 1K	30	1 ∿ 5S
1.01K ∿ 5K	100	505mS ∿ 2.5S
5.01K ∿ 20K	300	250mS ∿ 1S
20.1K ∿ 100K	1K	100mS ∿ 500mS
101K ∿ 500K	3K	100mS ∿ 250mS
501K ∿ 5M	10K	100mS ∿ 250mS
5.01M ∿ 50M	30K	100mS ∿ 250mS
50.1K ∿ 200M	100K	100mS
201M ∿ 1G	300K	100mS
1.01G ∿ 2.09G	1M	100mS

3.11.1 RESOLUTION BW

The RESOLUTION BW is defined as the 6 dB bandwidth of the IF filter. The set bandwidth determines the resolution on the frequency axis.

In AUTO COUPLED mode, the preset value is set according to the frequency span (see Table 3-7).

In data entry mode, the RESOLUTION BW can be set by pressing the RESOLUTION BW key and by using the STEP keys or number/units keys.

(a) Using the data knob

The data knob cannot be used for this purpose.

(b) Using the STEP keys

A value from 10 Hz to 3 MHz can be set with the 1-3 sequence.

(c) Using the number/units keys

A value from 10 Hz to 3 MHz can be input with the 1-3 sequence. If an intermediate value is input, the nearest value which is greater than the input value is assumed and set.

If a value less than 10 Hz is input, 10 Hz is set. If a value greater than 3 MHz is input, 3 MHz is set. The decimal point cannot be input.

3.11.2 VIDEO BW

The VIDEO BW function determines the video bandwidth after detection. When the VIDEO BW is narrowed, noise is averaged at measurement.

In AUTO COUPLED mode, the video bandwidth is set to the one step higher value than the RESOLUTION BW. In this case, noise is not averaged. In entry mode, a value can be set by pressing the VIDEO BW key

and by using the STEP keys or number/units keys.

(a) Using the data knob

The data knob cannot be used for this purpose.

(b) Using the STEP keys

A value from 1 Hz to 3 MHz can be set with the 1-3 sequence.

(c) Using the number/units keys

A value 1 Hz to 3 MHz can be input with the 1-3 sequence.
If an intermediate value is input, the nearest value which is greater than the input value is assumed and set.
If 0 Hz is input, 1 Hz is set. If a value greater than 3 MHz is input, 3 MHz is set. The decimal point cannot be input.

3.11.3 SWEEP TIME

(1) When the FREQUENCY SPAN is 100 Hz or greater, a SWEEP TIME can be set using 3 significant digits in the range of 20.0 ms to 1000 s (full scale).

In AUTO COUPLED mode, an optimal sweep time value is automatically calculated and set according to the combination of the FREQUENCY SPAN, RESOLUTION BW, and VIDEO BW. If the calculated results exceed 1000 seconds, 1000 seconds are set and the [UNCAL] LED goes on. In AUTO COUPLED mode, the SWEEP TIME is set to 100 ms or greater.

In MANUAL mode, a value can be set by pressing the SWEEP TIME key and by using the data knob, STEP keys, or number/units keys.

(a) Using the data knob

One turn of the data knob changes the set value by 40 steps. One step is approximately 1% of the current sweep time.

(b) Using the STEP keys

1, 2, 5 sequence

(c) Using the number/units keys

A sweep time can be directly set using 3 significant digits. For example, 500 ms can be set by pressing the SWEEP TIME, 5, 0, 0 and msec keys.

In MANUAL mode, if the set value is less than the optimal sweep time which the determined according to the combination of the FREQUENCY SPAN, RESOLUTION BW, and VIDEO BW (that is, if the sweep speed is too fast), the [UNCAL] LED goes on to indicate that a level measurement error may occur.

If the FREQUENCY SPAN value is 201 MHz or greater and the SWEEP TIME is less than 100 ms, the [UNCAL] LED always goes on. In the case, the SWEEP TIME must be set to 100 ms or greater.

(2) When the FREQUENCY SPAN is 0 Hz, MANUAL mode is always set and a SWEEP TIME can be set in the range of 10 μs to 1000 s. However, when the sweep time is less than 20 ms, only the 1-2-5 sequence can be used. When 20 ms or a value greater is to be entered, the data knob, STEP keys, or number/units keys can be used in the same way as explained in 3.11.3 (1) above. When a value less than 20 ms is to be entered, the data knob cannot be used.

3.11.4 INPUT ATTENUATOR

(1) An INPUT ATTENUATOR value can be set in 5 dB steps in the range of 0 to 55 dB.
In AUTO COUPLED mode, the preset value is set according to the REFERENCE LEVEL and RESOLUTION BW.
In entry mode, an INPUT ATTENUATOR value can be set by pressing the INPUT ATTENUATOR key and by using the STEP keys and number/units keys.

(a) Using the data knob

The data knob cannot be used for this purpose.

(b) Using the STEP keys

A value can be set in 5 dB steps.

(c) Using the number/units keys

A value from 0 to 55 dB can be input in 5 dB steps. If an intermediate value is input, the nearest value which is greater than the input value is assumed and set. If a value greater than 55 dB is input, 55 dB is set.

Even if the INPUT ATTENUATOR is changed, the REFERENCE LEVEL does not change.
Some REFERENCE LEVEL values limit the INPUT ATTENUATOR set values.

(2) When the SHIFT and INPUT ATTENU keys are pressed, the INPUT ATTENUATOR value can be changed without changing the internal IF GAIN. In this case, the REFERENCE LEVEL is changed according to the INPUT ATTENUATOR value which is entered.
In this case, an INPUT ATTENUATOR value can be entered in the same way as that in (1) above.

3.11.5 COUPLED FUNCTION Effectively

When the RESOLUTION BW, VIDEO BW, SWEEP TIME, or INPUT ATTENUATOR is set in AUTO COUPLED mode, ordinary measurements can be done without considering the set values.

However, MANUAL mode must be used in the following cases:

(1) RESOLUTION BW

(a) In COUNT mode, the RESOLUTION BW must be set to at least 5% of the FREQUENCY SPAN. When an FM wave or another modulated wave is to be measured, the center frequency of the signal is counted by setting the RESOLUTION BW which is wide enough to cover the sideband wave.

(b) When the VIDEO AVERAGING function is to be used, the RESOLUTION BW must be set to at least 0.5% of the frequency span.

(c) When the two-signal intermodulation distortion is to be measured with a considerably wide frequency span and with a lower noise level, the RESOLUTION BW must be set in MANUAL mode so that the set value is narrower than the value set in AUTO mode. However, the sweep time becomes longer in inverse proportion to the second power of the RESOLUTION BW.

(2) VIDEO BW

(a) When measurements with averaged noise are required, the VIDEO BW must be set to a narrow value. In AUTO COUPLED mode, the video bandwidth is the one step higher value than the RESOLUTION BW.
Therefore, noise is not averaged. However, the sweep time becomes longer in inverse proportion to the VIDEO BW value.

(b) Averaging can also be obtained by performing VIDEO AVERAGING (using the SHIFT and VIDEO BW keys) without narrowing the VIDEO BW (by increasing the sweep time). In this case, averaging is gradually obtained each time a sweep is done. Therefore, when necessary averaging is obtained, VIDEO AVERAGING can be stopped by pressing the DISPLAY VIEW key.

(3) SWEEP TIME

In AUTO COUPLED mode, a sweep time is set so that no level error occurs (the allowable level error is approximately 0.1 dB or less). When the entire signal image is to be quickly obtained even if some level errors may occur, the sweep time must be set in MANUAL mode so that the set value is less than the value which is set in AUTO mode.
(In this case, the [UNCAL] LED goes on.)

(4) INPUT ATTENUATOR

In AUTO COUPLED mode, the INPUT ATTENUATOR is set so that the maximum dynamic range is obtained for the secondary harmonic distortion caused when a signal having the same level as the REFERENCE LEVEL is input. Therefore, when a faint-level spurious other than a harmonic or a faint-level spurious near a signal is

to be measured by increasing the sensitivity the INPUT ATTENUATOR value can be reduced in the range where the mixer level (the value obtained by "INPUT LEVEL" minus "INPUT ATTENUATOR") is -10 dBm or less.

3.12 SWEEP

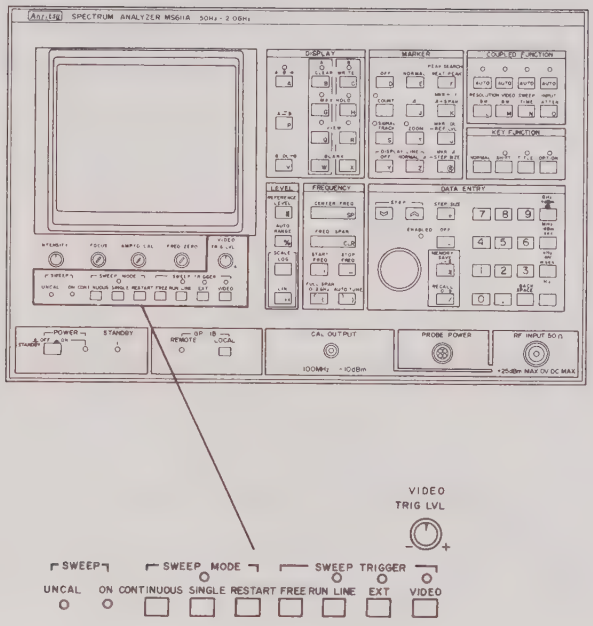


Fig. 3-42 SWEEP Setting

- Sweep can be controlled using the SWEEP MODE and SWEEP TRIGGER keys.
- During sweep, the [SWEEP ON] LED is on.
- If the sweep time is not appropriate, the [UNCAL] LED goes on.
  In this case, there is an error in the displayed frequency or level. Therefore, set AUTO COUPLED mode for sweep time setting or set a greater sweep time value in MANUAL mode so that the [UNCAL] LED goes off.
  Then, do the measurement again.
- When the DISPLAY mode is CLEAR/WRITE or MAX HOLD, the trace data is rewritten at each sweep. When the DISPLAY mode is VIEW or BLANK, the trace data is not rewritten and the previous data is retained.

- When the set frequency or level is changed, the trace may be disturbed temporarily but the next or later sweep is correctly done.
- When the frequency span is 0 Hz (time domain), a sweep time can be set to 10 µs to 10 ms. However, in this case, the digital storage does not operate and data is directly displayed.

3.12.1 SWEEP MODE

(1) CONTINUOUS mode

When the CONTINUOUS key is pressed, sweep is continuously repeated while the sweep trigger is given.
This mode is set when power is turned on or the FULL SPAN key is pressed.

(2) SINGLE mode

When the SINGLE key is pressed, sweep is done only once. When the RESTART key is pressed, sweep is done once again at the next trigger.
This mode cannot be used in time domain mode (sweep time is 10 µs to 10 ms).

(3) RESTART

When the RESTART key is pressed, sweep is retried from the left end of the screen, even during a sweep. This key is also used to start a sweep in SINGLE mode.
The RESTART key cannot be used in time domain mode (sweep time is 10 µs to 10 ms).

3.12.2 SWEEP TRIGGER

(1) FREE RUN mode

When the FREE RUN key is pressed the sweep trigger is internally set automatically.
This mode is set when power is turned on or the FULL SPAN key is pressed.

This mode is used for continuous sweep by combining with the SWEEP MODE CONTINUOUS function. When the FREE RUN mode is combined with the SWEEP MODE SINGLE function, sweep is done once when the RESTART key is pressed.

(2) LINE mode

When the LINE key is pressed, a trigger signal synchronized with the AC 50/60 Hz line is internally generated.

This mode is useful to measure signals synchronized with the AC line.

(3) EXT mode

When the EXT key is pressed, the sweep trigger is set using the external trigger input from the EXT TRIG connector. This trigger is set at the leading edge of the trigger input signal.

(4) VIDEO mode

When the VIDEO key is pressed, a trigger signal synchronized with a detected signal is internally generated. This trigger signal is synchronized with the leading edge of the detected signal. The level of the trigger point can be adjusted using the VIDEO TRIG LVL knob. The level can be moved to the plus or minus side from the average level. VIDEO TRIGGER mode is useful to observe waveforms in time domain mode (frequency span is 0 Hz).

3.13 SHIFT Key Functions

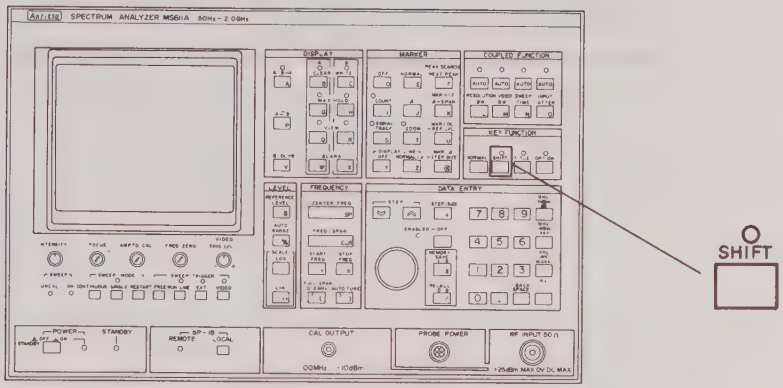


Fig. 3-43 SHIFT Key Function Location

When another key is pressed after pressing SHIFT key a function other than that indicated on the front panel is enabled. Some shift key functions are indicated by blue characters on the panel.

3.13.1 Table of Shift Key Functions

Table 3-8 shows the usable shift key functions.

Table 3-8 SHIFT Key Functions

FUNCTIONS			Key pressed after SHIFT	Reference (section)
DATA ENTRY	NEGATIVE ENTRY		ENABLED OFF	3.10.2 (Usable only for data entry is Δ MARKER mode)
LEVEL	UNIT: dBμ		+ dBm	3.8.1(1)
MARKER	ΔMARKER ON SCREEN		Δ	3.10.2(2)
	NEXT PEAK		PEAK SEARCH	3.10.6(2)
	LEFT PEAK		COUNT	3.10.6(3)
	CENTER PEAK		ZOOM	3.10.6(4)
	RIGHT PEAK		MKR→CF	3.10.6(5)
	NEAR MARKER PEAK		SIGNAL TRACK	3.10.6(6)
	ΔDISPLAY LINE		DL NORMAL	3.10.8(2)
	DL → REF.LEVEL		MKR → REF LVL	3.8.1(4)
DISPLAY	DETECTION MODE	NORMAL	Ach CLEAR/WRITE	3.13.4(1)
		POSITIVE PEAK	Ach MAX HOLD	3.13.4(2)
		NEGATIVE PEAK	Ach VIEW	3.13.4(3)
		SAMPLE	Ach BLANK	3.13.4(4)
	VIDEO AVERAGE	ON	VIDEO BW	3.13.3
		OFF	SWEEP TIME	3.13.3
SAVE	SAVE REG.LOCK/UNLOCK		SAVE	3.13.5
ADJUSTMENT	FREQ ZERO ADJ PRESET		LINE	3.5.1(3)
	AMPTD.CAL ADJ PRESET		RESTART	3.5.1(3)

Table 3-8 SHIFT Key Functions (Cont'd)

FUNCTION		Key pressed after SHIFT	Reference (section)
CALIBRATION	AUTO CAL	FREQ SPAN	3.13.2
	USE CAL DATA	CONTINUOUS	3.13.2
	DO NOT USE CAL DATA	SINGLE	3.13.2
INPUT ATTEN	INPUT ATTEN WITH IF GAIN FIXED	INPUT ATT	3.11.4(2)

3.13.2 AUTO CAL

The AUTO CAL routine automatically detects internal level errors and stores then in memory. Then, when a level parameter is set, the stored error data is automatically added to the displayed value so that the level will be corrected. This ensures accurate measurements.

The AUTO CAL routine can be executed in the following procedure:

(1) Connect the 100 MHz CAL OUTPUT connector to the RF INPUT connector.

(2) Press the FULL SPAN key.

(3) Press the SHIFT and SWEEP MODE SINGLE keys.

(4) Press the SHIFT and SWEEP TRIGGER LINE keys to adjust the FREQ ZERO value. Adjust so that the level of the trance displayed on the screen shows the maximum value.

(5) Press the SHIFT and SWEEP MODE RESTART keys to adjust the AMPTD CAL value. Adjust so that the level of the trace peak point displayed on the screen is -10.00 dBm.

⑥ Press the SHIFT and FREQ SPAN keys to execute the AUTO CAL routine.
When this execution ends, the [AUTO CAL] display on the screen is erased. During execution of the AUTO CAL routine, no data can be input using the keys on the front panel.

When AUTO CAL processing ends, the set values used before AUTO CAL execution are displayed again.

When the frequency span is 0 Hz and the sweep time is 10 µs to 10 ms, the AUTO CAL routine cannot be executed.

Execution of the AUTO CAL routine corrects the following parameters:

- o IF gain (internal parameter): 10 dB step with 10 dB reference
- o Level error due to RESOLUTION BW switching

The error data detected and stored by the AUTO CAL routine is cleared when power is turned off once.

If the AUTO CAL routine is executed without applying the 100 MHz CAL signal, [CALIBRATION ERROR] is displayed on the screen and execution ends. The same operation occurs when the signal is turned off during AUTO CAL execution.

AUTO CAL execution cannot be stopped by key operation before its completion. AUTO CAL execution can be stopped by turning off the power or the 100 MHz CAL signal.

In addition, after AUTO CAL is executed, error correction is automatically performed when each parameter is set. However, to skip the correction, press SHIFT, SWEEP MODE SINGLE.

When error correction must be performed again, press SHIFT, SWEEP MODE CONTINUOUS.

3.13.3 DIGITAL VIDEO AVERAGING

The DIGITAL VIDEO AVERAGING function smooths displayed traces by repeating sweep operations and by averaging the A/D-converted digital data. Since the VIDEO BW can be widened comparatively and the time for one sweep can be shortened, the entire image of the spectrum can be quickly obtained. Moreover, when the necessary smoothness is obtained, the sweep repetition can be stopped. When a sweep repetition count is previously input, the sweep stops at the count. By pressing the DISPLAY VIEW key, the sweep operation can be stopped.

Displayed traces can also be smoothed by narrowing the VIDEO BW. However, in this case, the time required for one sweep becomes longer and considerable time is required to obtained the entire image of the spectrum.

(1) The DIGITAL VIDEO AVERAGING function can be started by pressing the SHIFT and VIDEO BW keys. The averaging count is set to 100 when power is turned on or when the FULL SPAN key is pressed. Therefore, when the SHIFT and VIDEO BW keys are pressed, averaging is executed 100 times.

In this case, channel A or B is selected for a AVERAGING according to the set DISPLAY mode as follows:

(a) When channel A is in CLEAR/WRITE mode, channel B is set to BLANK mode and the trace data in channel A is averaged.

(b) When channel B is in CLEAR/WRITE mode and channel A is in other than CLEAR/WRITE mode, channel A is set to BLANK mode and the trace data in channel B is averaged.

(c) When both channels A and B are in other than CLEAR/WRITE mode, the buzzer sounds and AVERAGING is not executed.

(2) Averaging can be stopped by pressing the SHIFT and SWEEP TIME keys.

(3) The averaging count can be changed by pressing the SHIFT and VIDEO BW keys, by inputting a numeric value (2 to 1000), and by pressing a unit key. Since AVERAGING has been already started when the SHIFT and VIDEO BW keys were pressed, AVERAGING must be stopped by pressing the SHIFT and SWEEP TIME keys. Then, AVERAGING up to the newly set count can be started by pressing the SHIFT and VIDEO BW key again.

For example, AVERAGING up to 50 times can be executed by pressing the SHIFT VIDEO BW, 5, 0, GHz SHIFT, SWEEP TIME, SHIFT, and VIDEO BW keys.

In this case, the decimal point cannot be input.

(4) When a DISPLAY mode key is pressed during AVERAGING, the following operation occurs:

(a) When the VIEW key for channel A is pressed during channel A AVERAGING, AVERAGING stops. Other DISPLAY mode keys are not accepted.

(b) When the VIEW key for channel B is pressed during channel B AVERAGING, AVERAGING stops. Other DISPLAY mode keys are not be accepted.

(5) During AVERAGING, a set value for other than DISPLAY mode can be entered as required, but the spectrum after this entry will not be correctly displayed. Therefore, AVERAGING must be stopped once by pressing the SHIFT and SWEEP TIME keys, and must be restarted by pressing the SHIFT and VIDEO BW keys.

(6) When AVERAGING is executed the specified number of times, DISPLAY mode is set to VIEW. Averaging can be restarted by pressing the CLEAR/WRITE, SHIFT, and VIDEO BW keys.

(7) AVERAGING is executed in SAMPLE detection mode (see section 3.13.4). In SAMPLE mode, if the FREQUENCY SPAN is much greater than the RESOLUTION BW, the frequency interval to be sampled is too long and the displayed spectrum peak value may be reduced.
To prevent this, average under the following condition:

[Frequency span] < 200 x [resolution bandwidth]

When the A-B → A function is being executed, the VIDEO AVERAGING function cannot be used.

The SHIFT and VIDEO BW keys are pressed

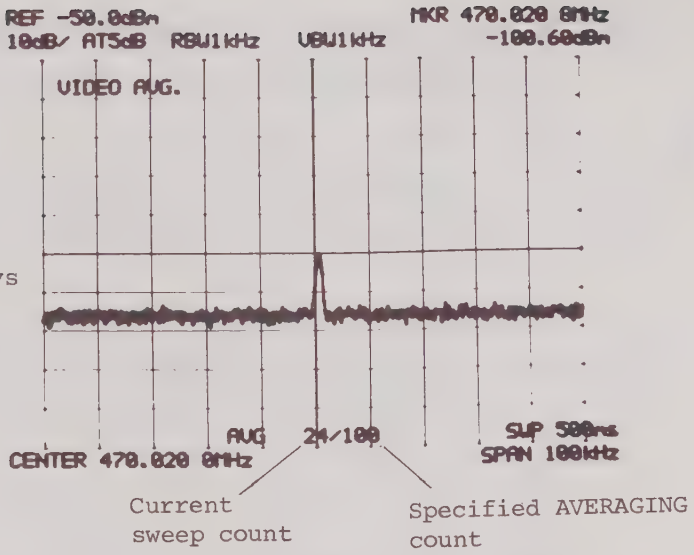


Fig. 3-44 SHIFT, VIDEO BW Display

3.13.4 Detection Modes

The following 4 detection modes can be used for a trace displayed on the screen.

Table 3-9 CRT Trace Mode

Mode	Key input	Purpose
NORMAL	SHIFT and DISPLAY channel A CLEAR/ WRITE keys or FULL SPAN key	Usable for most ordinary measurements
POSITIVE PEAK	SHIFT and DISPLAY channel A MAX HOLD keys	Used to clearly display a peak value of a signal whose level is near its noise level or used to measure the upper envelope of a modulated wave.
NEGATIVE PEAK	SHIFT and DISPLAY channel A VIEW keys	Used to measure the lower envelope of a modulated wave.
SAMPLE	SHIFT and DISPLAY channel A BLANK keys	Normally not used, but used for execution of the VIDEO AVERAGING function.

(1) NORMAL mode

In this case POSITIVE PEAK or NEGATIVE PEAK detection mode is automatically selected according to the input signal, for each memory point of the digital storage. The trace display is similar to the analog display.

(2) POSITIVE PEAK mode

When the SHIFT and DISPLAY channel A MAX HOLD keys are pressed, POSITIVE PEAK detection mode is set for each memory point of the digital storage.

So, for the noise, the upper envelope is displayed. Also, the peak value of a signal whose level is near the noise level can be clearly displayed. In NORMAL mode, the peak value of a signal whose level is slightly larger than the noise level is sometimes displayed incorrectly.

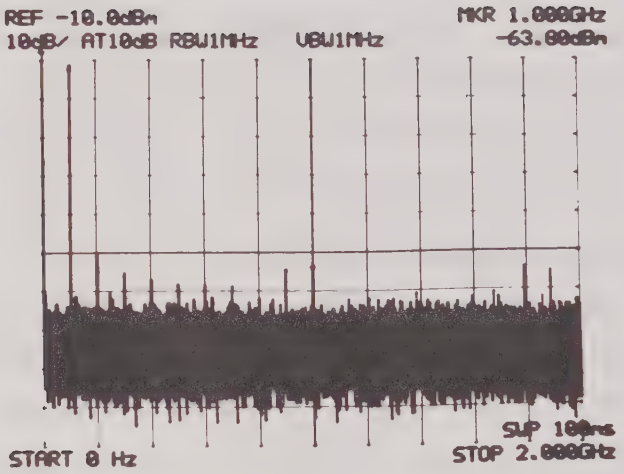
(3) NEGATIVE PEAK mode

When the SHIFT and DISPLAY channel A VIEW keys are pressed, NEGATIVE PEAK detection mode is set for each memory point of the digital storage.

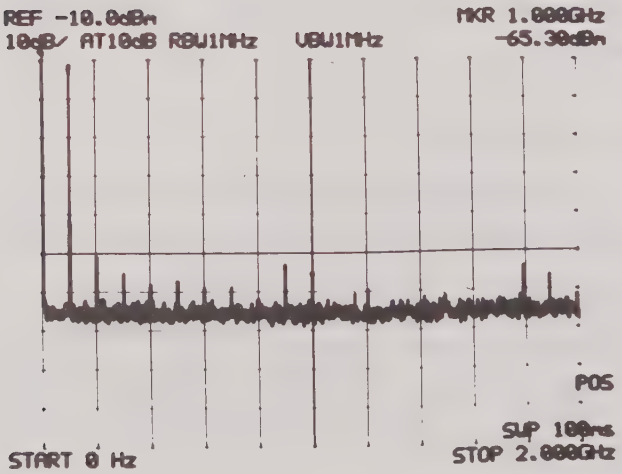
The peak value of a signal is not displayed correctly. So, for the noise, the lower envelope is displayed.

(4) SAMPLE mode

When the SHIFT and DISPLAY channel A BLANK keys are pressed, SAMPLE detection mode is set for each memory point of the digital storage.
Each instantaneous value is written for each memory point.

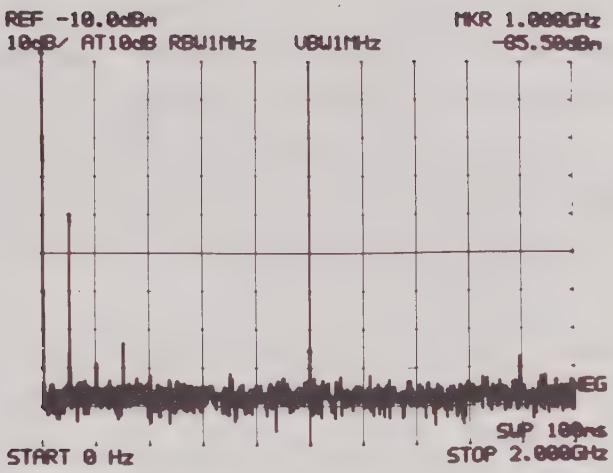


NORMAL mode

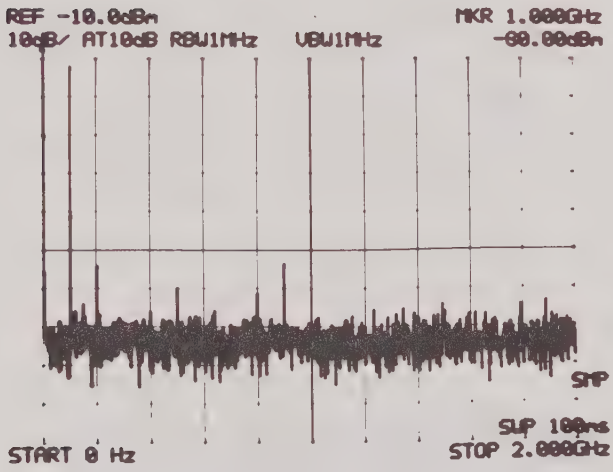


POSITIVE PEAK mode

Fig. 3-45 Detection Mode Display



NEGATIVE PEAK mode



SAMPLE mode

Fig. 3-45 Detection Mode Display (Cont'd)

3.13.5 SAVE REGISTER LOCK

The SAVE register can be locked to prevent the measurement parameter SAVE function (see section 3.5.4) from being mistakenly used.

When the SHIFT and SAVE keys are pressed, "SAVE: REG LOCKED" is displayed on the screen. After this, the SAVE key can not be used. If the SAVE key is pressed, the buzzer sounds.

To unlock the SAVE register and to enable the SAVE key again, press the SHIFT and SAVE keys again.

When "SAVE: REG UNLOCKED" is displayed on the screen, SAVE register is locked and then POWER is turned ON, the save register will not be locked.

3.14 TITLE Key Functions

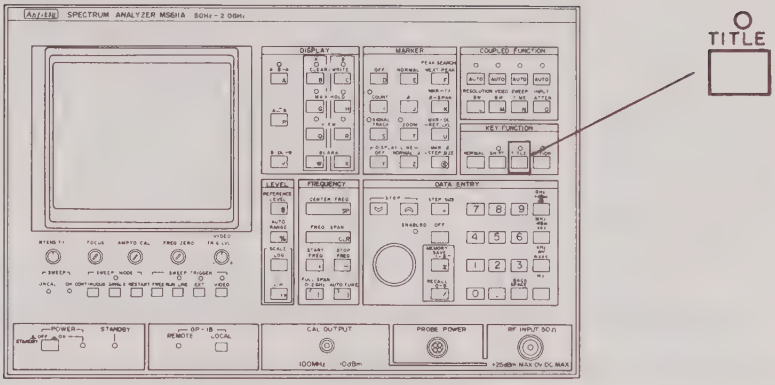


Fig. 3-46 Title Function Location

When the TITLE key is pressed, the "TITLE" LED goes on and the cursor (underline) is displayed at the left end of the top line on the SCREEN. In this case, 48 or fewer characters can be written on the top line by using the alphabetic character keys on the front panel.

For example, a measurement item, measurement data, and operator name can be displayed as a title. Therefore, this function is convenient when these measurement results are to be photographed.

Alphabetic characters, numeric characters, and special symbols indicated on the top of each key can be input as title characters.

When the SHIFT key is not pressed, capital letters and yellow symbols can be input. When the SHIFT key is pressed, that is, when the [SHIFT] LED is ON, small letters and blue symbols can be input.

The SHIFT state can be released by pressing the NORMAL key.

If incorrect data is input, the input characters can be erased one by one by using the BACK SPACE key. A space character can be input by using the SP key.

The cursor can be moved using the STEP keys ⋁ and ⋀, and characters can be written (or rewritten) at the desired position.

One line can be entirely erased by pressing the CLR (CLEAR) key.

To release the TITLE state and to return to the ordinary key input state, press the KEY FUNCTION NORMAL key. The cursor is erased.

Example of title input

TITLE, M, S, 6, 1, 1, and A keys are pressed.

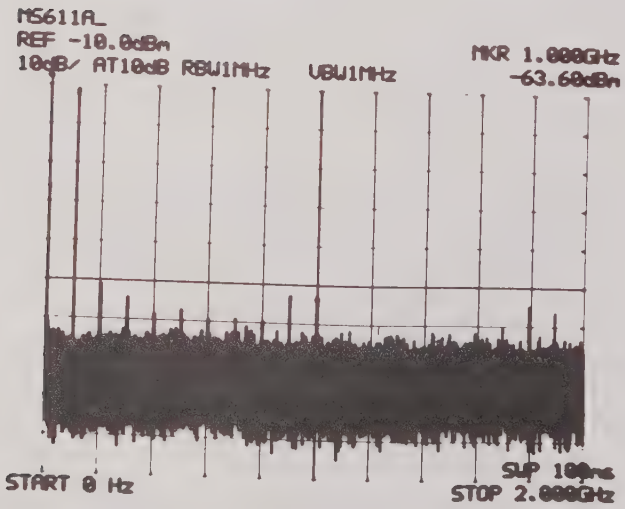


Fig. 3-47 TITLE Display

SECTION 4

GP-IB INTERFACE

4.1 General

The GP-IB interface is standard feature of the MS611A Spectrum Analyzer. The GP-IB (General Purpose Interface Bus) is a standard interface bus which conforms with IEEE-488 (United States Electrical and Electronics Association Standards) as well as the IEC-625 (International Electronics Standardization Commission) standards.

The GP-IB interface can control all MS611A front panel functions excluding POWER switch, CRT INTENSITY, FOCUS, VIDEO TRIGGER LEVEL, FREQUENCY ZERO and AMPLITUDE CAL adjustment. It also allows reading of marker and spectrum memory data. The GP-IB interface is easily used for developing flexible systems in combination with personal computers and measuring instruments.

4.2 GP-IB Functions

Table 4-1 shows the MS611A spectrum analyzer GP-IB functions.

Table 4-1 GP-IB Functions

GP-IB Function	Explanation
SH1	Supports the Source Handshake function
AH1	Supports the Accept Handshake function
T6	Supports the Talker function. Does not support the Talk Only function.
L4	Supports the Listener function. Does not support the Listen Only function.
SR1	Supports the Service Request function.
RL1	Supports the Remote Local function.
PP0	Does not support the Parallel Polling function.
DC1	Supports the Device Clear function. (Note 1)
DT1	Supports the Device Trigger function. (Note 2)
C0	Does not support the Controller function.

Note 1; When the Device Clear function is executed, the initialization status (the same status when FULL SPAN is pressed) occurs.

Note 2; When SWEEP TRIGGER is set to EXT (external trigger), sweep triggering is applied by executing the Device Trigger function.

4.3 GP-IB Address

The MS611A addresses are set using the address switch located on the rear side. The address set by this switch is read to the CPU when POWER is turned on. Therefore, power must be turned off if the address is to be altered.

(Address switch located on the rear side)

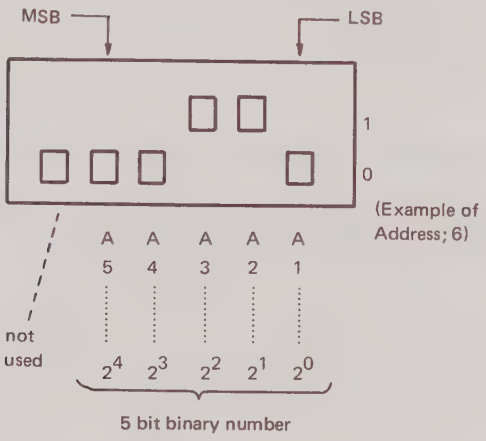


Fig. 4-1 Address Switch On Rear Panel

The address is set using a five-bit binary number. The rightmost ibt (A1) is the LSB (Least Significant Bit) bit and A5 is MSB (Most Significant) bit.

When set to the UP position, the switch indicates 1 and when set to the LOW position, it indicates 0.

4.4 GP-IB REMOTE CONTROL Functions

The MS611A remote control functions are as follows:

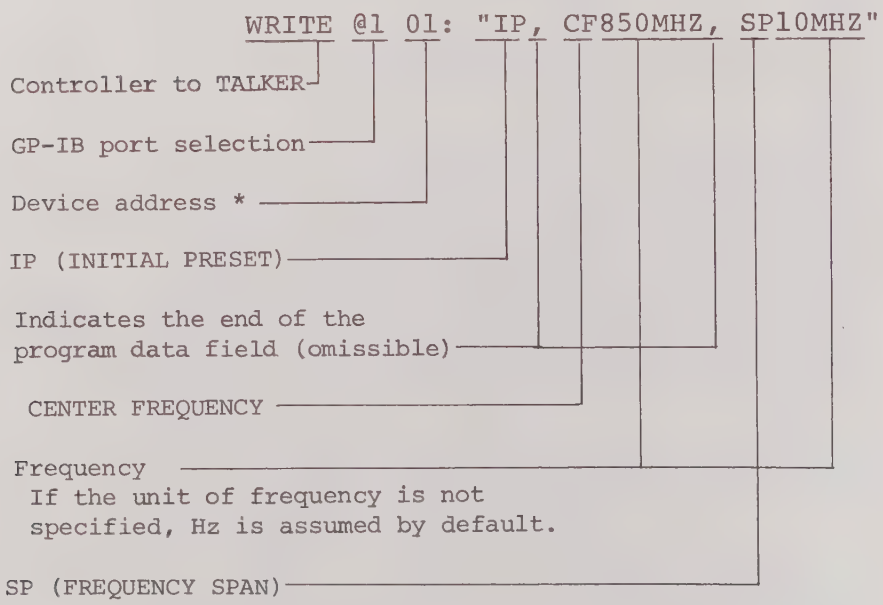
- Sets the front panel functions. For details, see section 4.5.
- Reads measurement data (marker point frequency and level, and spectrum). For details, see section 4.6.
- Displays the title on the screen. For details, see Section 4.7.

Program data tables (in alphabetical order) are attached in Table 4-20.

4.4.1 Setting Front Panel Functions

The program data of the required function must be sent. Program data can be entered in series.

Example: Center frequency 850 MHz and frequency span 10 MHz are set.


WRITE @1 01: "IP, CF850MHZ, SP10MHZ"
Controller to TALKER
GP-IB port selection
Device address *
IP (INITIAL PRESET)
Indicates the end of the program data field (omissible)
CENTER FREQUENCY
Frequency
If the unit of frequency is not specified, Hz is assumed by default.
SP (FREQUENCY SPAN)

* In following examples, the GP-IB port address and device address are set to @101 if the Packet II Hy PERSONAL COMPUTER is used.

4.4.2 Reading Measured Values

(1) To read marker values, send program data MF or MA, and OA.

Example: Reading the marker frequency and level

```
10 WRITE @101: "MF OAKHZ"
```

MF (MARKER FREQUENCY)

Unit (The default is Hz.)

OA (OUTPUT ACTIVE FUNCTION)

```
20 READ @101: F
```

Variable name assigned to the value read (arbitrary)

```
30 WRITE @101: "MA OA"
```

MA (MARKER AMPLITUDE)

```
40 READ @101: A
```

Note: When reading measured values, only one item can be read at a time.

(Example)

```
10 WRITE @101: "MF OA, MA OA"
20 READ @101: F, A
```

} The above specification is invalid.

(2) To read spectrum (trace) data, send program data (TA for A ch, TB for B ch). The controller will read the spectrum data.

Example: A ch spectrum data

```
10 DIM A(1000)
```

Array specification (1001 from A(0) to A(1000))

```
20 WRITE @101: "O3 , TA"
```

Sets the controller to TALKER

A ch data read specification.

Delimiter (Omissible)

```
30 FOR I = 0 TO 1000

40 READ @101:A(I)
```

Sets the controller to LISTENER

A ch data read specification

```
50 NEXT I
```

4.4.3 Display Titles

Any specified title can be displayed on the first line (48 characters) of the screen.

Example: Displaying the title: "SPURIOUS MEASUREMENT"

```
WRITE @101: "TT0 , SPURIOUS△ MEASUREMENT¥"
```

TT (TITLE)

Title start position

Text

Delimiter (required)

Terminator (5C in ASC11 format)

To clear the title, send the following:

```
WRITE @101: "T0"
```

4.5 Setting Front Panel Functions

The following four program data formats are used to set front panel functions:

- o Header (2 characters) + Numeric data + Unit
  Example: "CF123456HZ"
- o Header (2 characters) + Numeric data (integer)
  Example: "MP500"
- o Header (1 or 2 characters) + Numeric data (1 character)
  Example: "M1", "SV4"
- o Header (2 characters) only
  Example: "IP"

Specify the header and units using capital letters.

Specify numeric data using signed integers (NR1 format) or signed real numbers (including the decimal point) (NR2 format).

Example: (NR1) 850
(NR2) 850.00

For some items such as the frequency, negative values may not be specified.
Program data may be entered in series. In this case, the delimiter sign (a comma) or space is used to separate data. The delimiter sign is optional.

The end of program data is indicated by a line feed code (LF) or carriage return code (CR) + line feed code (LF).

The CR and LF codes are generated automatically in the Packet II [WRITE] command. For other controllers, see individual manuals.

The MS611A reads the program data from the controller until the line feed code is detected or a character count of 127 is reached, and checks the program data format.

If the program data is found to be valid, the data is executed. If an error is detected in the program data, all the entered program data is assumed to be invalid. At the same time, the message "ILLEGAL COMMAND" is displayed on the screen and GP-IB issues a service request. For details on the service request, see section 4.8.

4.5.1 Setting FREQUENCY

Table 4-2 FREQUENCY Setting

Item	Program data (example)
CENTER FREQUENCY	"CF123456HZ" (Note)
FREQUENCY SPAN	"SP156KHZ" (Significant digits: 3)
START FREQUENCY	"FA3.25MHZ"
STOP FREQUENCY	"FB1.34GHZ"

Note: Units for specifying the frequency are as follows:

Unit	Code	Abbreviation
Hz	HZ	The unit is omitted.
kHz	KHZ	KZ (or K)*
MHz	MHZ	MZ (or M)*
GHz	GHZ	GZ (or G)*

* In case of abbreviations K, M, and G, the delimiter (comma) or space must be entered if other program data follows.

4.5.2 Setting LEVEL

Table 4-3 List of LEVEL Setting

Item	Program data (example)
REFERENCE LEVEL	"RL-20DBM"
SCALE LOG	"LG10DB" └─If numeric data is omitted, 10 dB is assumed by default.
SCALE LIN	"LN"

Note: Units for specifying the level are as follows:

Unit	Code	Abbreviation
dBm	DBM	The unit is omitted.*
dB	DB	The unit is omitted.
dBμ	DBU	The unit is omitted.*
V	V	None
mV	MV	None
μV	UV	None

* If dBm or dBμ units are omitted, the unit of preceding REFERENCE LEVEL is assumed.

4.5.3 Setting COUPLED FUNCTION

Table 4-4 List of COUPLED FUNCTION Setting

Item	Program data (Example)
RESOLUTION BANDWIDTH (MANUAL)	"RB100KHZ" (Note 1)
RESOLUTION BANDWIDTH (AUTO COUPLED)	"CR"
VIDEO BANDWIDTH (MANUAL)	"VB300HZ" (Note 1)
VIDEO BANDWIDTH (AUTO COUPLED)	"CV"
SWEEP TIME (MANUAL)	"ST2.2S" (Note 2)
SWEEP TIME (AUTO COUPLED)	"CT"
INPUT ATTEN (MANUAL)	"AT10DB" (Note 3)
INPUT ATTEN (AUTO COUPLED)	"CA"

Note 1: The units for specifying RESOLUTION BW are identical to the frequency units (see Paragraph 4.5.1).

Note 2: The units for specifying SWEEP TIME are as follows:

Unit	Code	Abbreviation
S	S	None
ms	MS	M*
μs	μS	U*

* In case the abbreviated M and U unit codes are specified a delimiter (comma) or space must be entered if other program data follows.

Note 3: The INPUT ATTEN unit dB code is DB (omissible)

4.5.4 Setting MARKER

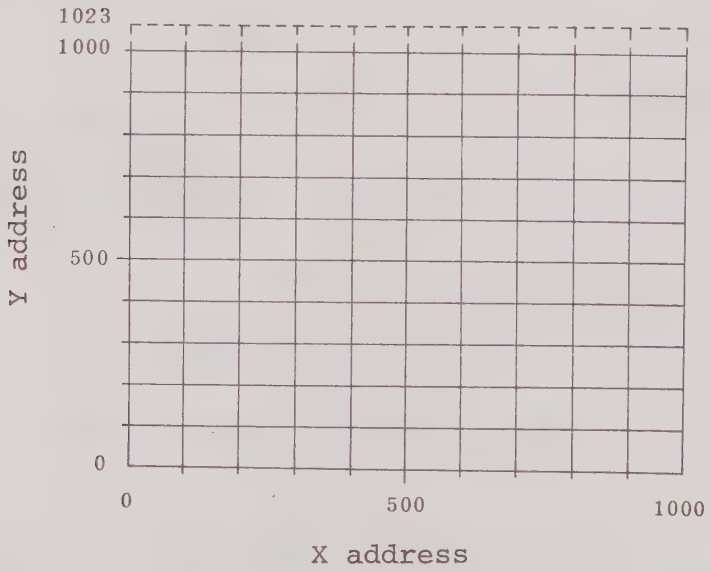
Table 4-5 List of MARKER Setting

Item	Program data (example)
NORMAL MARKER FREQUENCY	"MF1500MHZ" (Note 1)
NORMAL MARKER POSITION	"MP500" └─Marker X address. Specified by an integer in the range from 0 to 1000 (units not needed). (Note 3)
ΔMARKER FREQUENCY	"DF-100MHZ"
ΔMARKER POSITION	"DP-50" └─X address difference of the ΔMARKER. Specified by an integer in the range from ±0 to ±1000.
MARKER OFF (Note 2)	"M1"
NORMAL MARKER	"M2" (Note 1)
COUNT	"CN"
SIGNAL TRACK	"MT"
ZOOM	"M4"
PEAK SEARCH	"E1"
MKR → CF/Δ → SPAN	"E2"
MKR → STEP SIZE	"E3"
MKR → REF.LEVEL	"E4"
NEXT PEAK SEARCH	"E5"
LEFT PEAK SEARCH	"E6"
CENTER PEAK SEARCH	"E7"
RIGHT PEAK SEARCH	"E8"
NEAR MARKER PEAK SEARCH	"E9"

Note 1: NORMAL MARKER setting codes MF and M2 are supported. Frequency data must be coded following the MF code. M2 does not contain numeric data. It is used to switch from ΔMARKER to NORMAL MARKER etc.

Note 2: If COUNT, SIGNAL TRACK, or ZOOM has been set, the MARKER OFF code M1 clears these mode, and sets NORMAL MARKER mode.

Note 3: X and Y addresses are defined as follows:



4.5.5 Setting DISPLAY LINE

Table 4-6 List of DISPLAY LINE Setting

Item	Program data (example)
NORMAL DISPLAY LINE (LEVEL)	"DL-50.7DBM" (Note)
NORMAL DISPLAY LINE POSITION	"LP300" DISPLAY LINE Y address. Specify an integer in the range from 0 to 1000 units not needed.
ΔDISPLAY LINE POSITION	"DD-200" Y address difference of ΔDISPLAY LINE. Specified by an integer in the range from ±0 to ±1000 (units not needed).
DISPLAY LINE OFF	"LO"

Note: Only the dBm (→DBM) and dBμ (→DBU) DISPLAY LINE units are supported. The unit is omissible.

Unit V is not supported. If the REF LEVEL in SCALE LIN is in V units, the display line must be set in "LP" code (Y address setting).

4.5.6 Setting STEP SIZE and Step UP/DOWN

Table 4-7 List of STEP SIZE, STEP UP/DOWN Setting

Item	Program data (example)
FREQUENCY STEP SIZE	"CFSS100KHZ" (Note 1)
FREQUENCY STEP SIZE	"CFSSHZ" └ Only "Hz" may be specified here.
LEVEL STEP SIZE	"RLSS6DB"
LEVEL STEP SIZE	"RLSSDB"
STEP UP	"UP" Steps up to the CENTER FREQUENCY.
STEP DOWN	"RL DN" Steps down the REFERENCE LEVEL.

Note 1: The units for specifying FREQUENCY STEP SIZE are identical to the frequency units.

4.5.7 Setting SAVE/RECALL

Table 4-8 List of SAVE/RECALL Setting

Item	Program data (example)
SAVE	"SV4" Register numbers in the range from 1 to 9.
RECALL	"RC4" Register numbers in the range from 0 to 9.

4.5.8 Setting DISPLAY

Table 4-9 List of DISPLAY Setting

Item		Program data (Example)
DISPLAY Ach		
	CLEAR/WRITE	"A1"
	MAX HOLD	"A2"
	VIEW	"A3"
	BLANK	"A4"
DISPLAY Bch		
	CLEAR/WRITE	"B1"
	MAX HOLD	"B2"
	VIEW	"B3"
	BLANK	"B4"
A − B → A ON/OFF		"C2" When C2 is executed, ON and OFF operations are repeated alternately.
A B		"EX"
B − DL → B		"BL"
DETECTION MODE		
	NORMAL	"P1"
	POSITIVE PEAK	"P2"
	NEGATIVE PEAK	"P3"
	SAMPLE	"P4"

4.5.9 Setting SWEEP

Table 4-10 List of SWEEP Setting

Item	Program data (Example)
SWEEP MODE	
CONTINUOUS	"S1"
SINGLE	"S2"
RESTART	"S3"
SWEEP TRIGGER	
FREE RUN	"T1"
LINE	"T2"
EXT	"T3"
VIDEO	"T4"
TAKE SWEEP (Note 1)	"TS"

Note 1: In TAKE SWEEP, the SWEEP MODE is set to SINGLE, sweep is restarted and the following function is executed upon completion of the sweep. This function is required for controlling the MS611A using the GP-IB interface.

Assume that CENTER FREQ is set to 900 MHz, FREQ SPAN is set to 10 MHz and then the following program data is entered to execute a peak search.

```
WRITE @101: "CF900MHZ SP10MHz S3 E1"
```

Here, E1, which is the peak search, is executed after restarting S3. This means that peak search is executed before sweep is completed.
That is, before the spectrum data is updated. This causes the results to be unpredictable. Therefore, program data shall be coded as follows:

WRITE @101: "CF900MHZ SP10MHZ TS E1"

Here, E1 executes peak search upon completion of the sweep, TS. The results are, therefore, predictable.

4.5.10 Setting Other Functions

Table 4-11 List of Extra Setting

Item	Program data (Example)
INITIAL PRESET (FULL SPAN 0 - 2 GHz)	"1P"
AUTO TUNE	"TU"
AUTO RANGE	"AR"
AUTO CALIBRATION	"AC"
VIDEO AVERAGING ON	"AV100" Averaging count Specify in the range from 2 to 1000 (units not needed).
VIDEO AVERAGING OFF	"V0"

4.6 Reading Measured Values

To read measured values, program data requesting compilation of output data is input to the MS611A. Next, the controller sets the MS611A to TALKER mode to output the data.

The following data may be output.

Table 4-12 List of Read Out Program Code

Output data	Program code	Description
Marker frequency (or time)	MFOA	See paragraph 4.6.1
Marker level	MFOA	See paragraph 4.6.2
Spectrum data (1001 points)	TA, TB	See paragraph 4.6.3

The following 3 output data formats are supported. The required data format is specified beforehand. The output data format is set to "03" when power is turned on.

Table 4-13 List of Program Data

Program data	Output mode
01	The address in the range from 0 to 1000 (or 1023) displayed on the screen is output in decimal format (unsigned integer). For ΔMARKER, the address difference is output as a signed number. ASCII code (4 bytes) ASCII code terminator (Output beginning with the high-order byte)

Table 4-13 Program Data (Cont'd)

Program data	Output mode
02	The address in the range from 0 to 1000 (or 1023) displayed on the screen is output in binary format. For ΔMARKER, the negative difference address (-1 to -1023), is output in the form of two's complement. Binary (2 bytes) (Output in HIGH and LOW byte sequence)
03	Outputs the frequency or level in decimal format (signed real number). Code, including the decimal point ASCII code The number of bytes varies (data is output starting with the high-order byte). ASCII code terminator

* EOI is generated simultaneously with the final byte of the last data.

Note 1: If a measured value is to be output twice in series, the program data (MFOA etc.) must also be entered twice.

Example:

```
10 WRITE @101: "MFOA"
20 READ  @101: F1
30 READ  @101: F2
```

Although a correct value is entered in F1, the data sent to F2 contains asterisk (indicates no output data), which causes an error.

Note 2: If two or more measured values are to be read out in series, program data must be entered for each value.

Example:

```
10 WRITE @101: "MFOA,MAOA"
20 READ @101: F,A
```

The above will cause an error.

4.6.1 Reading the Marker Frequency (or time)

Marker display is as follows:

FREQUENCY SPAN ≠ 0 Hz : Frequency
FREQUENCY SPAN = 0 Hz : Time

The required data may be read using the above specification. In count mode, the frequency may be read even if FREQUENCY SPAN=0 Hz is specified (mode 03).

Table 4-14 List of reading MARKER

Output data	Output mode	Program mode
For FREQ SPAN ≠ 0 Hz		
NORMAL MARKER frequency	03	MFOA (frequency unit)
NORMAL MARKER X-address	01 or 02	MFOA
ΔMARKER frequency difference	03	MFOA (frequency unit)
ΔMARKER X-address difference	01 or 02	MFOA
COUNT frequency	03	MFOA (frequency unit)
For FREQ SPAN = 0 Hz		
NORMAL MARKER time	03	MFOA (time unit)
NORMAL MARKER X-address	01 or 02	MFOA
ΔMARKER time difference	03	MFOA (time unit)
ΔMARKER X-address	01 or 02	MFOA
COUNT frequency	03	MFOA (frequency unit)

Note: The ΔMARKER X-address difference indicates the address difference between the two marker points on the screen.
Note that the address difference output may be different from the equivalent frequency difference in mode 03.

An example of a program is shown below:

Example 1: To read the NORMAL MARKER frequency, ΔMARKER frequency difference, or COUNT frequency (output mode 03)

```
10 WRITE @101: "O3 MFOA KHZ"
```

- "O3" — Output mode
- "MFOA" — MARKER FREQ read specification
- "KHZ" — Unit HZ (omissible)
  - KHZ (KZ)
  - MHZ (MZ)
  - GHZ (GZ)

  (available for O3 mode only)

```
20 READ @101: F
```

- READ @101 — Specifies that the MS611A be set to TALKER and reads data to a variable.
- F — Arbitrary variable

Example 2: To output the NORMAL MARKER or MARKER X address difference in decimal format (output mode O1).

```
10 WRITE @101: "O1 MFOA"
```

- "O1" — Output mode
- "MFOA" — Units need not specified

```
20 READ @101: P
```

- P — Arbitrary variable

Example 3: To output the NORMAL MARKER X or ΔMARKER X address difference in binary format (output mode O2)

```
10 WRITE @101: "O2 MFOA"
```

- "O2" — Output mode
- "MFOA" — Units need not be specified

```
20 READ @101 USING "WH": P
```

- USING "WH" — Identifies the first byte in 2-byte binary data as the high-order byte.
- P — Arbitrary variable

Note 1: The output mode is set to mode O3 when power is switched on. Once and output mode is set, it remains set until it is changed. Therefore, the output mode need only be set once regardless of how often data is output.

4.6.2 Reading the MARKER Level

Table 4-15 List of reading MARKER LEVEL

Output data	Output mode	Program mode
NORMAL MARKER level	O3	MAOA <unit>
NORMAL MAEKER Y-address	O1 or O2	MAOA
ΔMARKER level difference	O3	MAOA (unit)
ΔMARKER Y-address difference	O1 or O2	MAOA

Note: The MARKER Y-address difference indicate the Y-address difference between the two marker points on the screen.
Note that, in mode O3, the difference output may be different from the reference level.

The units supported in mode O3 are listed in the following table.

Table 4-16 List of MARKER MODE

MARKER MODE	SCALE	REF.LEVEL unit	Output units	
			Units not specified	Unit specified
NORMAL	LOG	dBm	dBm	dBm, dBμ
	LOG	dBμ	dBμ	dBm, dBμ
	LOG	V, mV, μV	μV	dBm, dBμ, V, mV, μV
	LIN	V, mV, μV	μV	V, mV, μV
Δ(Delta)	LOG	dBm, dBμ V, mV, μV	dB	dB
	LIN	V, mV, μV	X	X

* Units other than those listed in the above table are ignored. Data is output assuming that the unit has not been specified.

Program examples are shown below:

Example 1: To read the NORMAL MARKER level or ΔMARKER level difference (output mode 03)

```
10 WRITE @101: "03 MAOA DBM"
```

- "03" — Output mode
- "MAOA" — Specification to read the MARKER level
- "DBM" — Unit (omissible)

```
20 READ @101: A
```

- A — Arbitrary variable

Example 2: To output the NORMAL MARKER Y-address or MARKER Y-address difference in decimal format (output mode 01)

```
10 WRITE @101: "01 MAOA"
```

- "01" — Output mode
- "MAOA" — Units need not be specified.

```
20 READ @101: A
```

- A — Arbitrary variable

Example 3: To read the NORMAL MARKER Y-address or MARKER Y-address difference in binary format (output mode 02).

```
10 WRITE @101: "02 MAOA"
```

- "MAOA" — The unit need not be specified.

```
20 READ @101 USING "WH": A
```

- "WH" — Identifies the first byte in the 2-byte binary data as the high-order byte.
- A — Arbitrary variable

4.6.3 Reading Spectrum Data

The spectrum data (1001 points) displayed on the screen can be read out consecutively.

Table 4-17 List of SPECTRAM DATA

Output data	Output mode	Program mode
Spectrum data A ch level	O3	TA
Spectrum data A ch Y-address	O1 or O2	TA
Spectrum data B ch level	O3	TB
Spectrum data B ch Y-address	O1 or O2	TB

Units supported in the mode O3 are listed in the following table.

Table 4-18 List of O3 Mode Unit

SCALE	REF.LEVEL unit	Output units	Remarks
LOG	dBm	dBm	
LOG	dB	dBμ	
LOG	V, mV, μV	dB or dBμ	The unit immediately before setting REF.LEVEL to unit V.
LIN	V, mV, μV	—	Not supported in mode O3.

Program examples are shown below.

Example 1: To read A ch spectrum data in mode 03.

(1) With FOR-NEXT loop

```
10 DIM A(1000)
```

Array specification
(1001 in the range from A(0) to A(1000)

```
20 WRITE @101: "03 TA"
30 FOR I=0 TO 1000
40 READ @101:A(I)
50 NEXT I
```

(2) With MAT READ

```
10 SEPARATER IS CHR$(10)
```

Sets the separator to line feed (LF)

```
20 DIM A(1000)
30 WRITE @101: "03 TA"
40 MAT READ @101:A
```

Reads consecutively to the specified array variable.

Example 2: To output B ch spectrum data in mode 01.

(1) With FOR-NEXT loop

```
10 DIM INT A(1000)
```

Specify an integer array

```
20 WRITE @101: "01 TB"
30 FOR I=0 TO 1000
40 READ @101:A(I)
50 NEXT I
```

(2) For MAT READ

```
10 SEPARATER IS CHR$(10)
```

Set the separator to line feed (LF)

```
20 DIM INT A(1000)
30 WRITE @101: "O1 TB"
40 MAT READ @101:A
```

Example 3: To output A ch spectrum data in mode O2.

(1) With FOR-NEXT loop

```
10 DIM INT A(1000)
20 WRITE @101: "O2 TA"
30 FOR I=0 TO 1000
40 READ @101 USING "WH" :A(I)
```

Reads 2 bytes as a single data (The byte output first is assumed to be the high-order byte.)

```
50 NEXT I
```

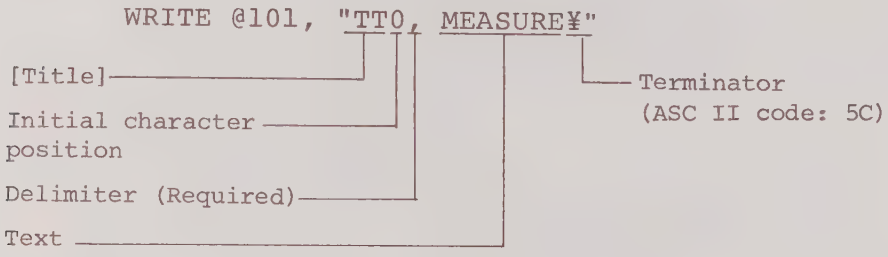
(2) For MAT READ

```
10 DIM INT A(1000)
20 WRITE @101: "O2 TA"
30 MAT READ @107 USING "WH":A
```

4.7 TITLE Display

A character string can be displayed in the title field (upper most line, 48 characters) of the screen by using the program code "TT".

Example



WRITE @101, "TT8, DATA Δ 1 Δ JUN Δ 81¥"

Note 1: The length of the title cannot exceed one line (48 characters).

Note 2: Since "¥" (ASCII code: 5C is reserved as a terminator code, it cannot be used in the text.

4.8 Service Request

The MS611A issues a service request under the following conditions. The cause of the service request can be identified by reading the status byte (serial polling by the controller).

Table 4-19 Service Request

Cause of service request	Status byte	Screen display
The incoming program data cannot be analyzed and executed normally.	0100 0010 (decimal 66)	GP-IB ILLEGAL COMMAND
Error in AUTO CAL	0110 0100 (decimal 100)	CALIBRATION ERROR

An example of a program on the controller side in response to a service request is shown below:

```
10 PROCESS EVENT GPIB "@01, 02" ..... Interrupt from GPIB
       GPIB selection code              SRQ bit number
20 START GPIBSRQ ..... Execute parallel processing (GPIBSRQ)
30 CONNECT EVENT GPIB ..... Enable interrupt
40 WRITE @101: "IP, CF100MHZ .....
                    (Main program)
190 END ........ End of main program
200 PARACT GRIBSRQ URGENCY50  ..... Define parallel processing (GRIBSRQ)
210 WAIT EVENT GPIB ..... Wait for interrupt from GPIB
220 STATUS @101:A ....... Read status byte
230 PRINT "SRQ": A
              (Processing program)
290 GOTO 210
300 END PARACT  .....  End of parallel processing
```

Table 4-20 MS611A GP-IB Program Data

(In alphabetical order)

Code	Format	Function
AC	AC	AUTO CALIBRATION
AR	AR	AUTO RANGE
AT	AT <Numeric><Unit> └─Specify DB or omit	INPUT ATTEN 0 to 55 dB (5 dB steps)
A1	A1	DISPLAY A ch CLEAR/WRITE
A2	A2	DISPLAY A ch MAX HOLD
A3	A3	DISPLAY A ch VIEW
A4	A4	DISPLAY A ch BLANK
BL	BL	B - DL → B
B1	B1	DISPLAY B ch CLEAR/WRITE
B2	B2	DISPLAY B ch MAX HOLD
B3	B3	DISPLAY B ch VIEW
B4	B4	DISPLAY B ch BLANK
CA	CA	AUTO COUPLED INPUT ATTEN
CF	CF <Numeric><UNIT> └─HZ (Omissible) KHZ (KZ) MHZ (MZ) GHZ (GZ)	CENTER FREQUENCY Sets 1 Hz units
CN	CN	MARKER COUNT MODE
CR	CR	AUTO COUPLED RESOLUTION BAND-WIDTH
CT	CT	AUTO COUPLED SWEEP TIME
CV	CV	AUTO COUPLED VIDEO BANDWIDTH
C2	C2	A - B → A ON/OFF (Alternately repeats ON/OFF operations will each execution)

Table 4-20 MS611A GP-IB Program Data (Cont'd)

Code	Format	Function
DB		Unit dB INPUT ATTEN, SCALE LOG, REF. Used to set INPUT ATTEN, SCALE LOG, and REF.LEVEL STEP SIZE
DBM		Unit dBm Used to set REF.LEVEL and DISPLAY LINE
DBU		Unit dBμ (e.m.f.) Used to set REF.LEVEL and DISPLAY LINE
DD	DD <Numeric>	ΔDISPLAY LINE Used to set the Y-address difference (±0 to ±1000)
DF	DF <Numeric><Unit> HZ (Omissible) KHZ (KZ) MHZ (MZ) GHZ (GZ)	ΔMARKER FREQUENCY Set in 1 Hz units
DL	DL Numeric Unit DBM (Omissible) DBU (Omissible)	DISPLAY LINE Units are identical to the REF.LEVEL units (Only dBm and dBμ).
DN	DN	STEP DOWN of the function which is set just before.
DP	DP Numeric	ΔMARKER POSITION Used to set the X-address difference (±0 to ±1000)
EX	EX	A ⇄ B
E1	E1	PEAK SEARCH
E2	E2	MKR → CF/Δ → SPAN
E3	E3	MKR → STEP SIZE
E4	E4	MKR → REF LEVEL
E5	E5	NEXT PEAK SEARCH
E6	E6	LEFT PEAK SEARCH

Table 4-20 MS611A GP-IB Program Data (Cont'd)

Code	Format	Function
E7	E7	CENTER PEAK SEARCH
E8	E8	RIGHT PEAK SEARCH
E9	E9	NEAR MARKER PEAK SEARCH
FA	FA <Numeric><Unit> └HZ (Omissible) KHZ (KZ) MHZ (MZ) GHZ (GZ)	START FREQUENCY Set in 1 Hz units
F8	F8 <Numeric><Unit> └HZ (Omissible) KHZ (KZ) MHZ (MZ) GHZ (GZ)	STOP FREQUENCY Set in 1 Hz units
GHZ		Unit: GHz
GZ		Unit: Abbreviation of GHz
HZ		Unit: Hz
IP	IP	INITIAL PRESET (FULL SPAN 0-2 GHz)
KHZ		Unit: kHz
KZ		Unit: Abbreviation of kHz
LG	LG	Scale LOG 10 dB/div
	LG <Numeric><Unit> └DB (Omissible)	SCALE LOG Used to set the Y-address (in the range from 0 to 1000).
LN	LN	SCALE LIN
LP	LP Numeric	DISPLAY LINE POSITION Used to set the Y-address (in the range from 0 to 1000).
LO	LO	DISPLAY LINE OFF
MA	MAOA	Outputs the MARKER level or ΔMARKER level difference.

Table 4-20 MS611A GP-IB Program Data (Cont'd)

Code	Format	Function
MF	MF <Numeric><Unit> └ HZ (Omissible) KHZ (KZ) MHZ (MZ) GHZ (GZ)	NORMAL MARKER FREQUENCY
	MFOA	Reads the MARKER frequency (time) or ΔMARKER frequency difference (time difference).
MHZ		Unit: MHZ
MP	MP <Numeric>	Sets the NORMAL MARKER POSITION X-address (0-1000)
MS		Unit: ms Used to set SWEEP TIME.
MT	MT	SIGNAL TRACK
MV		Unit: mV Used to set REF.LEVEL
MZ		Unit: Abbreviation of MHz
M1	M1	MARKER OFF If COUNT, SIGNAL, TRACK or ZOOM has been set, it is turned off and NORMAL MARKER mode is set.
M2	M2	NORMAL MARKER
M4	M4	ZOOM
OA	MFOA <Unit> └ HZ (Omissible) KHZ (KZ) MHZ (MZ) GHZ (GZ)	Reads the NORMAL MARKER frequency (time), ΔMARKER frequency (time) difference, and COUNT frequency.
	MAOA Unit └ DBM DBU V } NORMAL MARKER MV UV DB X } ΔMARKER	Reads the NORMAL MARKER level or ΔMARKER level difference.

Table 4-20 MS611A GP-IB Program Data (Cont'd)

Code	Format	Function
O1	O1	Output mode 1 Output addresses (0 to 1000 or 1023) or the address difference (0 to ±1000 or ±1023) in decimal format.
O2	O2	Output mode 2 Outputs addresses (0 to 1000 or 1023) or the address difference (0 to ±1000 and ±1023) in binary format (2 bytes).
O3	O3	Output mode 3 Outputs the frequency of frequency level in decimal format.
P1	P1	DETECTION MODE NORMAL
P2	P2	DETECTION MODE POSITIVE PEAK
P3	P3	DETECTION MODE NEGATIVE PEAK
P4	P4	DETECTION MODE SAMPLE
RB	RB <Numeric><Unit> └ HZ (Omissible) KHZ (KZ) MHZ (MZ)	RESOLUTION BANDWIDTH Sets 10 Hz to 3 MHz in sequences 1 to 3.
RC	RC Numeric One number in the range from 0 to 9.	RECALL Sets the register number
RL	RL <Numeric><Unit> └ DBM (Omissible) DBU (Omissible) V MV UV	
S		Unit: s Used to set SWEEP TIME

Table 4-20 MS611A GP-IB Program Data (Cont'd)

Code	Format	Function
SP	SP <Numeric><Unit> HZ (Omissible) KHZ (KZ) MHZ (MZ) GHZ (GZ)	FREQUENCY SPAN Used to set 0 or 3 significant digits from 100 Hz to 2.09 GHz.
SS	CFSS <Numeric><Unit> HZ (Omissible) KHZ (KZ) MHZ (MZ) GHZ (GZ)	FREQUENCY STEP SIZE
	CFSSHZ	Initializes FREQUENCY STEP SIZE
	RLSS <Numeric><Unit> DB	REF.LEVEL STEP SIZE
	RLSSDB	Initializes REF.LEVEL STEP SIZE
ST	ST <Numeric><Unit> S MS US	SWEEP TIME 10 µs to 10 mS: Sequences 1, 2, and 5 20 mS to 1000S: Three significant digits
SV	SV <Numeric> One number in the range from 1 to 9.	SAVE Sets the register number
S1	S1	SWEEP MODE CONTINUOUS
S2	S2	SWEEP MODE SINGLE
S3	S3	SWEEP MODE RESTART
TA	TA	Reads A ch spectrum data
TB	TB	Reads B ch spectrum data
TS	TS	TAKE SWEEP
TT	TT <Numeric>,<Text><Terminator> 0∿47 Code "5C"	Enters the title

Table 4-20 MS611A GP-IB Program Data (Cont'd)

Code	Format	Function
TU	TU	AUTO TUNE
T0	T0	Clears the title
T1	T1	SWEEP TRIGGER FREE RUN
T2	T2	SWEEP TRIGGER LINE
T3	T3	SWEEP TRIGGER EXT
T4	T4	SWEEP TRIGGER VIDEO
UP	UP	STEP UP
US		Unit: μS Used to set SWEEP TIME
UV		Unit: μV Used to set REF.LEVEL
V		Unit: V Used to set REF.LEVEL
VA	VA <Numeric>	VIDEO AVERAGING Sets the count in the range from 2 to 1000.
VB	VB <Numeric><Unit> └ HZ (Omissible) KHZ (KZ) MHZ (MZ)	VIDEO BANDWIDTH Used to set 1 Hz to 3 MHz in sequence 1 and 3.
VO	VO	VIDEO AVERAGING OFF

SECTION 5

PRINCIPLE OF OPERATION

5.1 General

The MS611A is a super-heterodyne scanning type spectrum analyzer. The block diagram of the entire system is shown in Fig. 5-2.

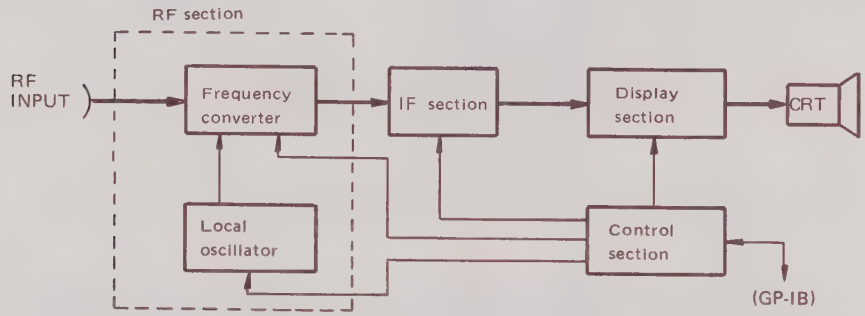


Fig. 5-1 Spectrum Analyzer Block Diagram

The RF input is converted to IF frequency by the mixer of frequency converter in the RF section. The signal detected while passing through the IF section is stored in the digital storage memory of the display section. The screen displays the frequency domain. The horizontal axis indicates the frequency while the vertical axis indicates the level. All sections are controlled by the control section with a built-in microcomputer.

5.2 RF Section

The RF section block diagram is shown in Fig. 5-2.

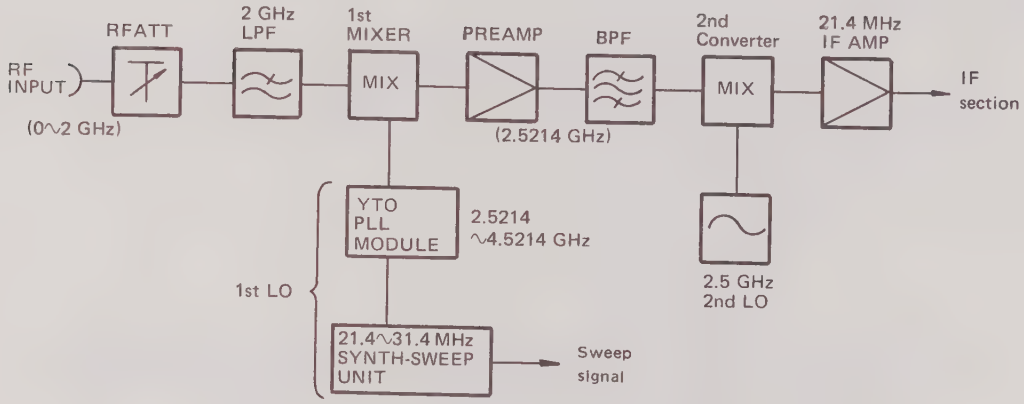


Fig. 5-2 RF Section Block Diagram

The input signal is applied to the first mixer via RF ATT and 2 GHz LPF. The YTO (YIG Tuned Oscillator) based on synthesizer technology applies a 2.5214 to 4.5214 GHz first local signal to the first mixer. The input RF signal is converted to a 2.5214 GHz IF signal.

The 2.5214 GHz IF signal is applied to the second converter via the BPF. The signal is converted to a 21.4 MHz IF signal using the 2.5 GHz second local signal. The signal is then routed to the IF section.

The first local oscillation section consists of a YTO PLL MODULE which contains the YTO and 10 MHz step synthesizer section and the 21.4 to 31.4 MHz SYNTH-SWEEP UNIT which interpolates the 10 MHz range. The frequency tuning and sweep functions are executed by the first local oscillator.

The second local oscillator is locked to 2.5 GHz.

5.3 IF Section

The IF section block diagram is shown in Fig. 5-3.

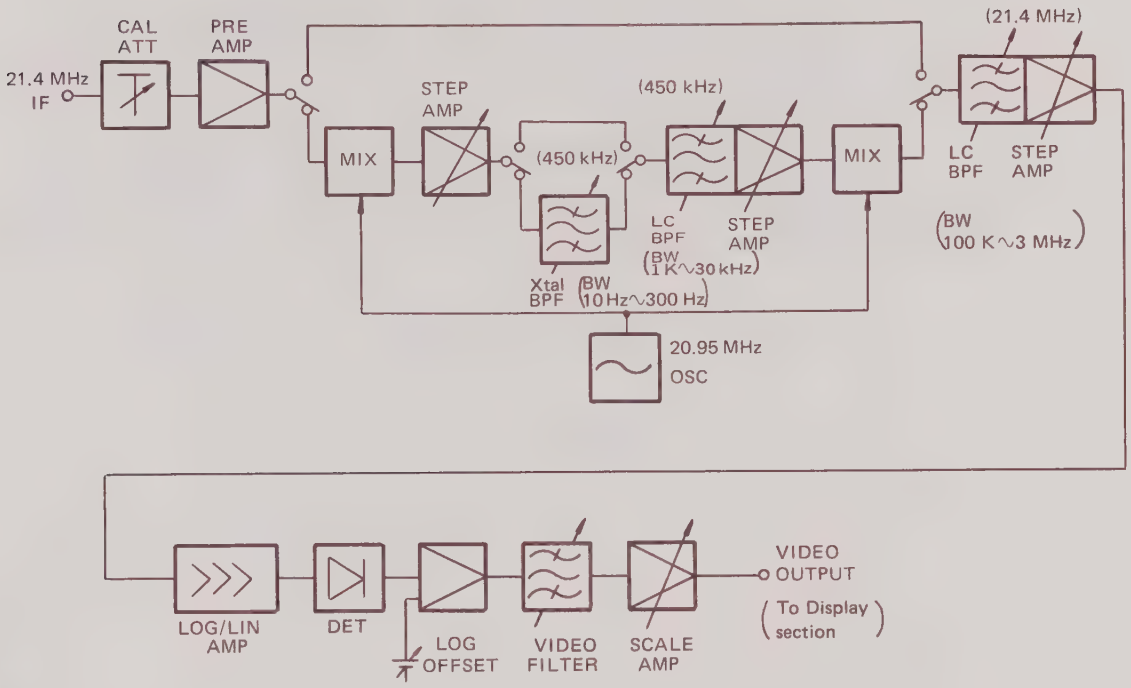


Fig. 5-3 IF Section Block Diagram

The processing of the 21.4 MHz IF signal is determined by its bandwidth (over 100 kHz or below 30 kHz) after passing through the CAL ATT and PRE AMP.

If the bandwidth is below 30 kHz, it is converted to a 450 kHz signal by the mixer. For the bandwidth between 10 Hz and 300 Hz, the bandwidth is determined by crystal type BPF. For the bandwidth between 1 to 30 kHz, the bandwidth is determined by LC type BPF.

The signal after passing through the IF circuit is reconverted to a 21.4 MHz signal by the mixer and is applied to the 21.4 MHz LC type BPF.

If the bandwidth is equal to or higher than 100 kHz, the signal is not routed via the 450 kHz IF circuit but is directly applied to the 21.4 MHz LC type BPF. The bandwidth is determined here.

The 21.4 MHz IF signal after passing through the LC type BPF and step-up amplifier is analyzed at the LOG/LIN amplifier.

After being analyzed, the signal is routed to the display section via the LOG OFFSET circuit, VIDEO FILTER, and SCALE AMP.

5.4 DISPLAY and CONTROL Sections

The block diagram of the display and control sections are shown in Fig. 5-4.

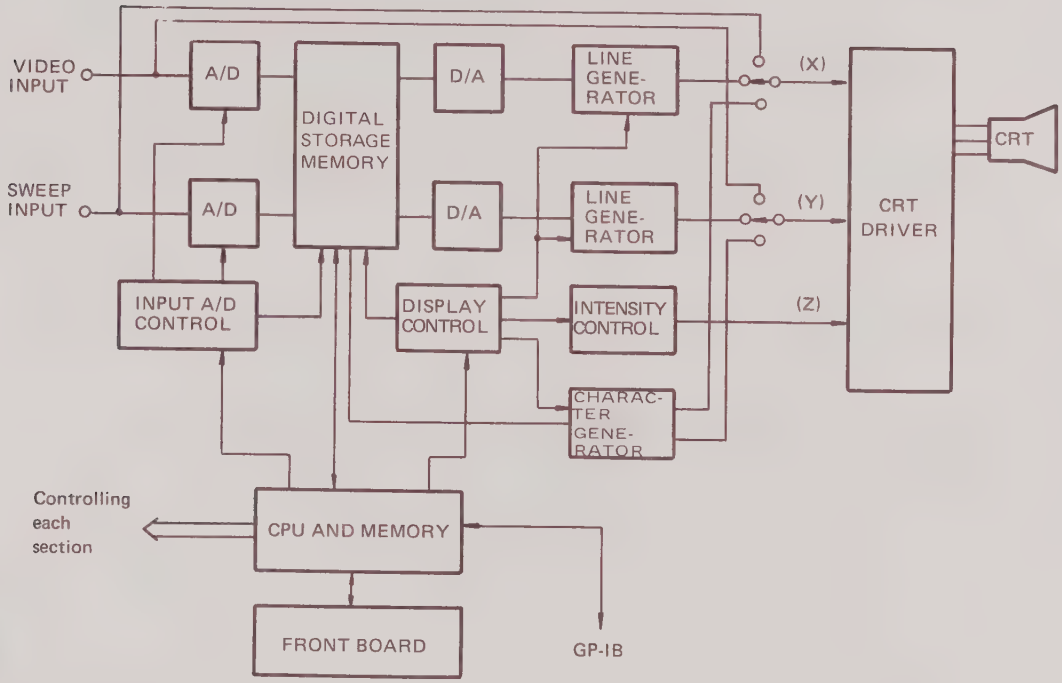


Fig. 5-4 Display and Control Section Block Diagram

The VIDEO signal from the IF circuit is stored in the digital storage memory (excluding FAST SWEEP in time domain). The storage address is computed by A/D conversion of the sweep signal. For display to the screen, the data from the memory is read and subjected to D/A conversion (independent refresh cycles for spectrum data and graticule) and fed to the CRT DRIVER circuit through the line generator. The CHARACTER GENERATOR circuit is used to display characters.

Control signals from the front panel are routed to the CPU AND MEMORY section and used to set the handware sections. The control signals are also used to control the digital storage functions.

SECTION 6

PERFORMANCE TEST

6.1 INTRODUCTION AND DESCRIPTION

The TEST INSTRUMENT'S performance is verified according to Table 6-1.

The TEST PERFORMANCE SHEET is prepared on page 6-76 to 6-100.

Notes:

(1) Specifications are guaranteed for temperatures from 0°C to 50°C.

(2) The TEST INSTRUMENT must be warmed up for 30 minutes or more, unless otherwise specified in the test precedure.

Table 6-1 Calibration Description

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS	TEST METHOD
1. Center frequency Readout Accuracy	±(Tuning frequency x Reference frequency error + 1.5% of frequency span + 50% of resolution bandwidth)	The center frequency readout accuracy is checked by receiving a known frequency signal.
2. Frequency Span Readout Accuracy	±(2.5% of frequency difference between 2 points + 0.5% of frequency span)	The frequency span readout accuracy is checked by measuring the frequency difference between two points on the spectrum on the display.
3. Count Accuracy	Readout frequency x Reference frequency error ±2 count.	The count accuracy is checked by counting CAL OUTPUT signal.
4. Reference Oscillator Stability	Frequency: 10 MHz Warmup characteristics: $\leq$ 1 x 10^{-7}/day after 30 minutes warm-up $\leq$ 5 x 10^{-8}/day after 60 minutes warm-up Aging characteristics: $\leq$ 2 x 10^{-8}/day after 24 hours warm-up Temperature characteristics: $\leq$ ±5 x 10^{-8} at 25°C ±25° of crystal oscillator ambient temperature	The frequency is measured at 24 hours interval after 30 or 60 minuites warm-up. The frequency is measured at 24 hours interval after 24 hours warm-up. The frequency is measured at 0°C, 25°C and 50°C.
5. Resolution Bandwidth Selectivity	Selectivity (60 dB/6 dB): < 10:1 (3 MHz to 100 kHz) < 7:1 (30 kHz to 10 Hz)	The selectivity is obtained by measuring 60 dB bandwidth and dividing this value by 6 dB bandwidth.

Table 6-1 Calibtation Description (Cont'd)

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS	TEST METHOD
6. Residual FM	≦ 2 Hzp-p/0.1 sec at frequency span ≦ 10 kHz	The residual FM is measured by detecting frequency variation for 0.1 sec.
7. Drift	≦ 50 Hzp-p/min at frequency span ≦ 10 kHz, and constant ambient temperature after one hour warm-up	The drift is measured by detecting frequency variation for one minute after one hour warm-up.
8. Noise Sidebands	≦ -80 dBc at 2 kHz away from the signal, resolution bandwidth 100 Hz, video bandwidth 3 Hz, and frequency 1 GHz or less.	The noise sidebands is measured by a pure signal supplied from a low phase noise signal generator.
9. CRT Display Linearity	LOG: ±0.2 dB/dB ±1.5 dB/80 dB LIN: ±3% of reference level (full scale)	The display linearity is measured by decreasing the signal level with a calibrated external attenuator.
10. Calibrator Output Level	-10 dBm ±0.3 dB	The calibrator output level at the point of the accessory cable is measured with a power meter.
11. Frequency Response	±1.5 dB (50 Hz to 1.5 GHz) +1.5 -3.0 dB (1.5 to 2 GHz)	The frequency response is measured by slowly sweeping or stepping a accurate level generator over the frequency range.
12. Reference Level Step Error	After automatic calibration ±0.8 dB (0 to -50 dBm, input attenuator 10 dB) ±1.5 dB (+25 to -100 dBm, input attenuator variable)	The reference level step error is determined by measuring IF 10 dB step gain error, IF 1 dB step gain error, IF 0.1 dB gain error, and input attenuator step error.

Table 6-1 Calibration Description (Cont'd)

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS	TEST METHOD
13. Resolution Bandwidth Switching Accuracy	±0.4 dB after automatic calibration (The 100 kHz bandwidth is used as the reference bandwidth)	The gain error is measured by switching the resolution bandwidth.
14. LOG Scale Switching Accuracy	±0.5 dB	The gain error is measured by switching the LOG scale.
15. Average Noise Level	At input attenuator 0 dB and resolution bandwidth 10 Hz, ≦ -135 dBm (0.8 to 2000 MHz) ≦ -110 dBm (500 Hz to 800 kHz) ≦ -80 dBm (50 to 500 Hz)	The average noise level is measured at 10 Hz resolution bandwidth without any input signal.
16. Second Harmonic Distortion	When the value obtained by subtracting the attenuation value from the input level is -30 dBm, ≦ -80 dB (100 to 900 MHz)	The second harmonic distortion is measured with a low distortion signal source.

Table 6-1 Calibration Description (Cont'd)

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS	TEST METHOD
17. Two-signal Third Order Intermodulation	When the value obtained by subtracting the attenuation value from the input level is -25 dBm, ≦ -80 dB (at frequency 20 to 1000 MHz and frequency difference 2.5 MHz) ≦ -70 dB (at frequency difference 1 kHz to 2.5 MHz)	The two-signal third order intermodulation distortion is measured by applying signals from two separate signal generators.
18. Residual Response	At input attenuator 0 dB and 50 Ω terminated, ≦ -110 dBm (1 MHz or higher) ≦ -100 dBm (2 kHz to 1 MHz) ≦ -80 dBm (50 Hz to 2 kHz)	The residual responce is checked across frequency range with no signal applied to the input.
19. RF Input Impedance	50 Ω, VSWR ≦ 1.5 (input attenuator ≧ 10 dB)	The return loss is measured by SWR autotester.
20. Power Consumption	** Vac ±10%, 50/60 Hz, ≦ 230 VA	The power consumption is measured by measuring AC voltage and AC current.

6.2 EQUIPMENT REQUIREMENTS

Note:

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment. Satisfactory performance of alternate items should be verified prior to using. All applicable equipment must bear evidence of current calibration.

Table 6-2 Equipment Requirements

Item	Generic Term	Minimum Use Specifications	Calibration Equipment
T6.2.1	SIGNAL GENERATOR	° Frequency range 60 MHz to 1 GHz ° SSB phase noise ≦ -110 dBc/Hz at 2 kHz offset ° 10 MHz EXT FREQ STD INPUT is provided ° Second harmonic ≦ -30 dBc	MG655A
T6.2.2	ATTENUATOR	° Frequency range DC to 100 MHz ° Impedance 50 Ω ° Step dial 10 dB x 8, 1 dB x 10 0.1 dB x 10, 3 dials. ° With attenuator calibration data	MN510C
T6.2.3	FREQUENCY COUNTER	° Measurement frequency 10 MHz ° Display 9 digits ° Accuracy ±1 count + Time base accuracy ° Time base stability ≦ $\pm 2 \times 10^{-9}$/day	MF57A (with OPT02)

Table 6-2 Equipment Requirements (Cont'd)

Item	Generic Term	Minimum Use Specifications	Calibration Equipment
T6.2.4	POWER METER with POWER SENSOR	° Frequency Range 10 MHz to 2 GHz ° Measuring power range -20 to 0 dBm ° Calibtation accuracy 0.15 dB ° Recorder output is provided.	ML83A with MA72A
T6.2.5	SWEEP OSCILLATOR with RF PLUG-IN	° Frequency range 10 MHz to 2 GHz ° Maximum leveled power > 0 dBm ° External ALC is provided.	HP8620C with HP86222A
T6.2.6	SYNTHSIZER/ LEVEL GENERATOR	° Frequency range 50 Hz to 10 MHz ° Maximum output level > 0 dBm ° Digital sweep start-stop sweep mode is provided	MG443B
T6.2.7	LOGARITHMIC LEVEL METER		
T6.2.8	VSWR AUTO TESTER		
T6.2.9	RC OSCILLATOR	° Frequency range 50 Hz to 20 kHz ° Distortion 0.01%	VP7220C
T6.2.10	AC METER	° AC Ammeter 0 to 10 A, ±1% ° AC Voltmeter 0 to 300 V, ±1%	FLUKE 8010A
T6.2.11	TERMINATION	° Frequency range DC to 2 GHz ° Impedance 50 Ω	MP752A
T6.2.12	ISOLATION BRIDGE		MP659A

Table 6-2 Equipment Requirements (Cont'd)

Item	Generic Term	Minimum Use Specifications	Calibration Equipment
T6.2.13	LOW PASS FILTER	° Cutoff frequency 120 MHz ° Attenuation > 55 dB at 200 MHz	
T6.2.14	POWER SPLITTER	° Frequency range 10 MHz to 2 GHz ° Insertion loss 6 dB ° Output tracking < 0.15 dB	HP11667A
T6.2.15	T-TYPE ADAPTER	BNC(J) - BNC(J) - BNC(J)	
T6.2.16	N(P) - N(P) ADAPTER	(Type N male to type N male)	
T6.2.17	N(J) - N(J) ADAPTER	(Type N female to type N female)	

6.3 PRELIMINARY OPERATIONS

(1) Turn on the power of the TEST INSTRUMENT.

(2) Warm up the TEST INSTRUMENT for about 30 minutes.

Note:

In the frequency stability test, warm up the TEST INSTRUMENT according to calibration procedure for this test.

6.4 CALIBRATION PROCEDURE

Note:

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met.

6.4.1 Center Frequency Readout Accuracy

This test measures the center frequency readout accuracy by receiving a known frequency signal. Since the signal generator is locked at the TEST INSTRUMENT reference frequency, the "tuning frequency × reference frequency accuracy" term of the specifications can be ignored.

Apply the known frequency to the TEST INSTRUMENT by signal generator, and compare the frequency with displayed center frequency on the TEST INSTRUMENT. Check the accuracy at several different frequencies.

6.4.1.1 Specifications

Accuracy: ±(Tuning frequency × Reference frequency error + 1.5% of frequency span + 50% of resolution bandwidth)

6.4.1.2 Setup

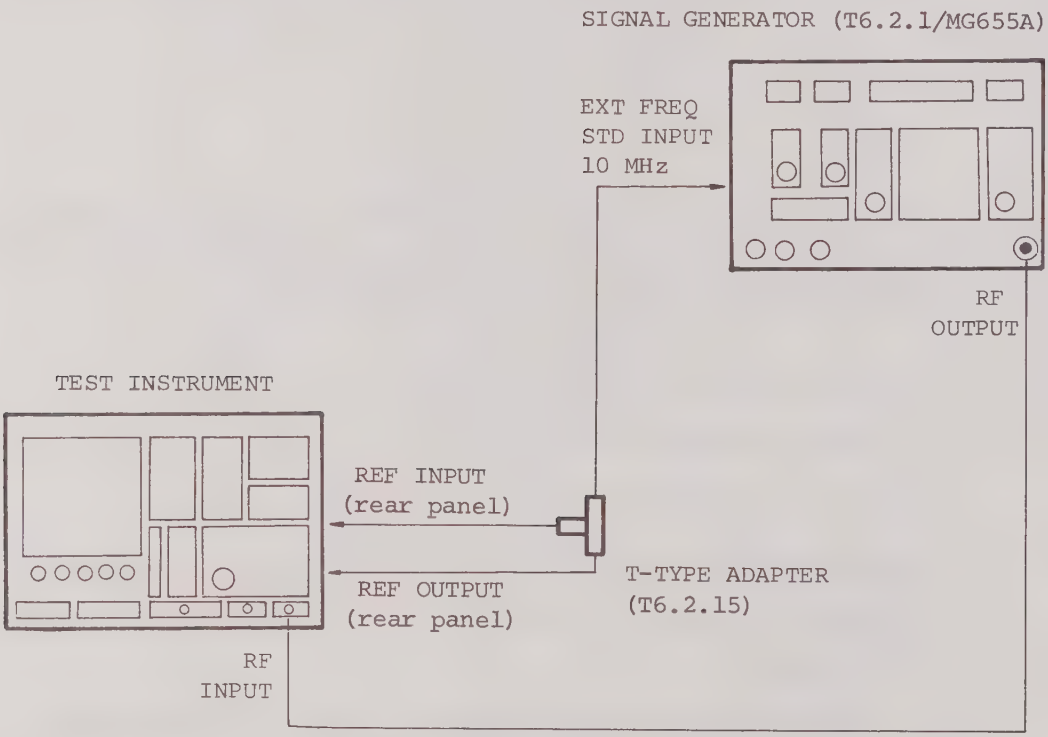


Fig. 6-1 Center Frequency Display Accuracy Test

6.4.2.3 Procedures

(1) Press FULL SPAN, SHIFT, and SWEEP TRIGGER LINE keys, in order. (FREQ ZERO ADJUST presetting is performed with SHIFT and SWEEP TRIGGER LINE.)

(2) Connect the CAL OUTPUT connector to the RF INPUT connector.

(3) Adjust FREQ ZERO for maximum level value on the signal trace.

(4) Press the FULL SPAN key.

(5) Set up the instruments as shown in Fig. 6-1.

(6) Set the signal generator as follows:

Oscillation frequency ... CENTER FREQUENCY value of Table 6-3.

Output level ..... -10 dBm

(7) Set the TEST INSTRUMENT FREQUENCY SPAN and CENTER FREQUENCY controls as shown in Table 6-3, and press PEAK SEARCH and MKR → CF keys, in order.

(8) Read the MARKER frequency display. This value must be within the range given in Table 6-3.

(9) Repeat steps (6) through (8) for CENTER FREQUENCY and FREQUENCY SPAN in Table 6-3.

Table 6-3 Center Frequency Readout Accuracy Test

CENTER FREQUENCY	FREQUENCY SPAN	RESOLUTION BW (AUTO)	Readout		
			Minimum specified value	Marker frequency	Maximum specified value
100MHz	1kHz	30Hz	99.999970MHz		100.000030MHz
100MHz	10kHz	300Hz	99.99970 MHz		100.00030 MHz
100MHz	100kHz	1kHz	99.9980 MHz		100.0020 MHz
100MHz	1MHz	10kHz	99.980 MHz		100.020 MHz
100MHz	10MHz	30kHz	99.84 MHz		100.16 MHz
100MHz	100MHz	100kHz	98.5 MHz		101.5 MHz
1GHz	1kHz	30Hz	999.999970MHz		1.000000030 GHz
1GHz	10kHz	300Hz	999.99970 MHz		1.00000030 GHz
1GHz	100kHz	1kHz	999.9980 MHz		1.0000020 GHZ
1GHz	1MHz	10kHz	999.980 MHz		1.000020 GHz
1GHz	10MHz	30kHz	999.84 MHz		1.00016 GHz
1GHz	100MHz	100kHz	998.5 MHz		1.0015 GHz

6.4.2 Frequency Span Readout Accuracy

This test checks the frequency span accuracy by measuring the frequency difference between two points on the spectrum on the display.

6.4.2.1 Specifications

Frequency Span Readout Accuracy:
±(2.5% of frequency difference between 2 points + 0.5% of frequency span)

6.4.2.2 Setup

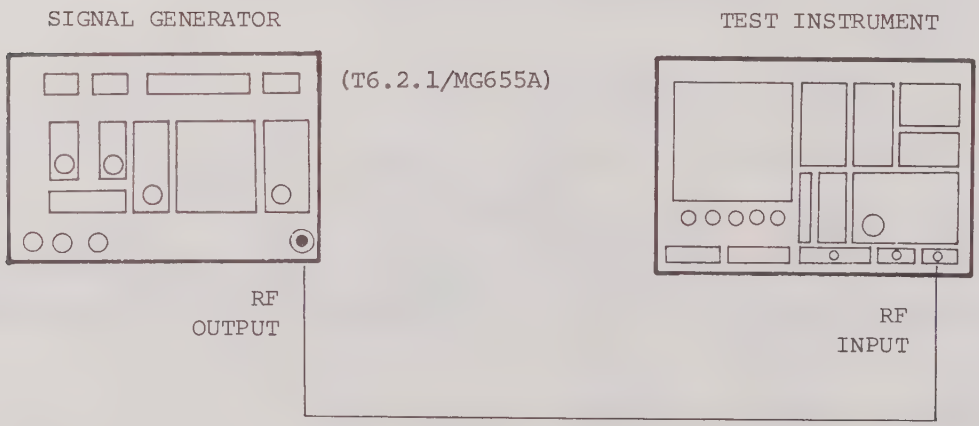


Fig. 6-2 Frequency Span Readout Accuracy Test

6.4.2.3 Procedures

(1) Press FULL SPAN key.

(2) Set the TEST INSTRUMENT as follows:

FREQUENCY SPAN ..... 1 kHz
CENTER FREQUENCY .... 100 MHz

(3) Set up the instruments as shown in Fig. 6-2, and set the signal generator as follows (1st measurement setting):

Oscillation frequency ... 99.9996 MHz
(100 MHz - 0.4 kHz)

Output level ..... -10 dBm

(4) Press the MARKER; PEAK SEARCH and Δ keys, in order.

(5) Reset the signal generator as follows (2nd measurement setting):

Oscillation frequency ... 100.0004 MHz
(100 MHz + 0.4 kHz)

Output level ..... -10 dBm

(6) Press the MARKER; PEAK SEARCH key.

(7) Read the Δ marker display value. This value should be within the range of the specified value of Table 6-4.

(8) Repeat steps (2) through (6) at each setting in Table 6-4.

Table 6-4 Frequency Span Accuracy Test

FREQUENCY SPAN	CENTER FREQUENCY	Signal generator setting		Readout		
		1st measurement setting	2nd measurement setting	Minimum specified value	Δ marker display value	Maximum specified value
1kHz	100MHz	99.9996MHz	100.0004MHz	775Hz	_____	825Hz
10kHz	100MHz	99.996 MHz	100.004 MHz	7.75kHz	_____	8.25kHz
20kHz	100MHz	99.992 MHz	100.008 MHz	15.50kHz	_____	16.50kHz
1MHz	100MHz	99.6 MHz	100.4 MHz	775kHz	_____	825kHz
2MHz	100MHz	99.2 MHz	100.8 MHz	1.550MHz	_____	1.650MHz
100MHz	100MHz	60 MHz	140 MHz	77.5MHz	_____	82.5MHz
1GHz	500MHz	100 MHz	900 MHz	775MHz	_____	825MHz

6.4.3 Count Accuracy

Reference frequency error relates to count accuracy. In this test, being used CAL OUTPUT signal made from the reference frequency, ±2 count of the count components is checked.

6.4.3.1 Specifications

Count Accuracy:

Readout frequency × Reference frequency error ±2 counts.

Note:

The level at the marker position must be 20 dB or more higher than the noise level or the level of the interference from adjacent signals. Also, the resolution bandwidth must be 5% or more of the frequency span.

6.4.3.2 Setup

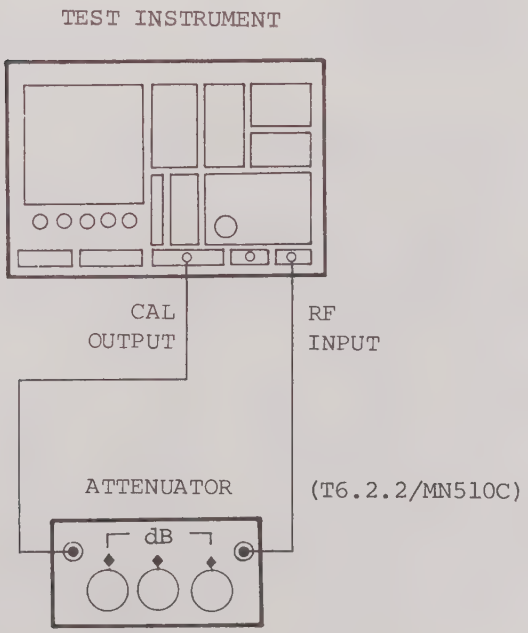


Fig. 6-3 Count Accuracy Test

6.4.3.3 Procedures

(1) Press FULL SPAN.

(2) Connect CAL OUTPUT to RF INPUT through attenuator with 0 dB setting.

(3) Set the TEST INSTRUMENT as follows:

CENTER FREQUENCY ... 100 MHz
FREQUENCY SPAN .... 50 MHz
RESOLUTION BW ..... 3 MHz

(4) Press PEAK SEARCH and COUNT. Read the count frequency.

(5) Press MARKER NORMAL and place the marker at the slope of response approximately 20 dB higher than the noise level.

(6) Press COUNT and read the count frequency.

(7) Set the TEST INSTRUMENT as follows:

FREQUENCY SPAN ..... 5 kHz
RESOLUTION BW ..... 300 Hz
MARKER ..... NORMAL

(8) Adjust the attenuator so that the peak of the signal is displayed approximately 20 dB higher than the noise level.

(9) Press PEAK SEARCH and COUNT. Read the count frequency.

(10) Each count frequency readout should be 100.000000 MHz ±0.000002 MHz.

6.4.4 Reference Oscillator Stability

This test measures the reference frequency of the TEST INSTRUMENT with a frequency counter having a reference frequency source with an aging rate one digit better than the reference frequency source of the TEST INSTRUMENT.

6.4.4.1 Specifications

- Frequency : 10 MHz
- Warm-up characteristics : $\leq 1 \times 10^{-7}$/day after 30 minutes warm-up

  $\leq 5 \times 10^{-8}$/day after 60 minutes warm-up
- Aging characteristics : $\leq 2 \times 10^{-8}$/day after 24 hours warm-up
- Temperature characteristics : $\leq \pm 5 \times 10^{-8}$ at 25°C ±25°C of crystal oscillator ambient temperature

6.4.4.2 Setup

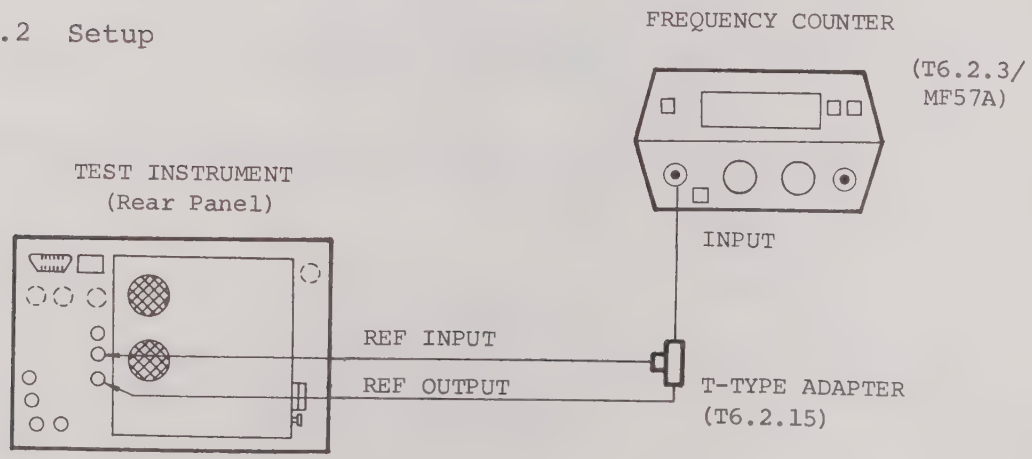


Fig. 6-4 Reference Oscillator Stability Test

6.4.4.3 Warm-up characteristics and aging characteristics test procedures

The TEST INSTRUMENT should be placed in the constant ambient temperature within ±1°C during this test.

(1) Set up the instruments as shown in Fig. 6-4.

(2) Turn on the power switch of the TEST INSTRUMENT.

(3) Measure the three respective frequencies after 30 minutes (F1), 60 minutes (F2) and 24 hours warm-up (F3).

(4) Measure the three frequencies (F1', F2' and F3') respectively 24 hours after performing procedure (3).

(5) Determine the warm-up characteristics and the aging characteristics as follows:

- Warm-up characteristics per day after 30 minites warm-up

$$= \frac{F1 - F1'}{F1'}$$

- Warm-up characteristics per day after 60 minites warm-up

$$= \frac{F2 - F2'}{F2'}$$

- Aging characteristics per day after 24 hours warm-up

$$= \frac{F3 - F3'}{F3'}$$

6.4.4.4 Temperature characteristics test procedures

(1) Place only the TEST INSTRUMENT in the constant temperature chamber and set up the instruments as shown in Fig. 6-4.

Note: This test should be performed after 24 hours or more warming-up.

(2) Measure the three respective frequencies at 0°C, at 25°C and at 50°C.

(3) Determine the temperature characteristics as follows:

- Temperature characteristics (25°C - 50°C)

$$= \frac{\text{(Frequency at 50°C) - (Frequency at 25°C)}}{\text{(Frequency at 25°C)}}$$

- Temperature characteristics (25°C - 0°C)

$$= \frac{\text{(Frequency at 0°C) - (Frequency at 25°C)}}{\text{(Frequency at 25°C)}}$$

MEMO

6.4.5 Resolution Bandwidth Selectivity

Resolution bandwidth selectivity is obtained by measuring the 60 dB bandwidth, and dividing this value by the 6 dB bandwidth for each resolution bandwidth setting from 10 Hz to 3 MHz. The CAL OUTPUT is used as the stable signal source.

6.4.5.1 Specifications

Selectivity (60 dB/6 dB): < 10:1 (3 MHz to 100 kHz)
< 7:1 (30 kHz to 10 Hz)

6.4.5.2 Setup

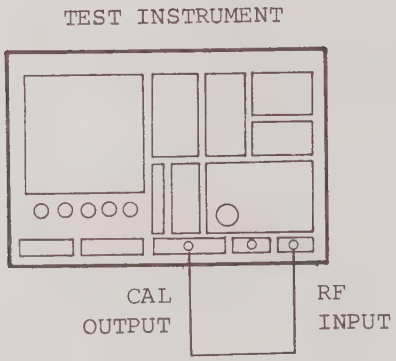


Fig. 6-5 Resolution Bandwidth Selectivity Test

6.4.5.3 Procedures

(1) Press FULL SPAN.

(2) Connect CAL OUTPUT to RF INPUT.

(3) Set the TEST INSTRUMENT as follows:

CENTER FREQUENCY ..... 100 MHz
FREQUENCY SPAN ..... 5 MHz
RESOLUTION BW ..... 3 MHz

SCALE ..... LOG 1 dB/div
DISPLAY Ach .. CLEAR/WRITE

(4) Adjust REFERENCE LEVEL to position peak of signal trace at reference level (top) graticule line.

(5) Press DISPLAY Ach VIEW after completion of sweep.

(6) Press PEAK SEARCH. Press MARKER Δ, and move the active marker to the signal trace moved 6 dB down to the left from the peak point so the Δ MARKER LEVEL display value is closest to -6.00.

(7) Press MARKER NORMAL, and Δ, and move the active marker to the signal trace moved 6 dB down to the right from the peak point so the Δ MARKER LEVEL display value is closest to 0.00.

(8) Read the 6 dB bandwidth from the Δ MARKER FREQUENCY display.

(9) Change the TEST INSTRUMENT settings as shown in Table 6-5, and repeat steps (3) through (8) at each setting.

Table 6-5 6 dB Bandwidth

RESOLUTION BW	FREQUENCY SPAN	Δ MARKER Readout of 6 dB Bandwidth
3 MHz	5 MHz	_____
1 MHz	2 MHz	_____
300 kHz	500 kHz	_____
100 kHz	200 kHz	_____
30 kHz	50 kHz	_____
10 kHz	20 kHz	_____
3 kHz	5 kHz	_____
1 kHz	2 kHz	_____
300 Hz	500 Hz	_____
100 Hz	200 Hz	_____
30 Hz	100 Hz	_____
10 Hz	100 Hz	_____

(10) Press FULL SPAN.

(11) Set the TEST INSTRUMENT as follows:

CENTER FREQUENCY	100 MHz
FREQUENCY SPAN	30 MHz
RESOLUTION BW	3 MHz
VIDEO BW	1 kHz
DISPLAY Ach	CLEAR/WRITE

It may be necessary to adjust CENTER FREQUENCY so that both 60 dB points are displayed.

(12) Press DISPLAY Ach VIEW after completion of sweep.

(13) Press PEAK SEARCH. Press MARKER Δ, and move the active marker to the signal trace moved 60 dB down to the left from the peak point so the Δ MARKER LEVEL display value is closest to -60.0.

(14) Press MARKER NORMAL, and Δ, and move the active marker to the signal trace moved 60 dB down to the right from the peak point so the Δ MARKER LEVEL display value is closest to 0.00.

(15) Read the 60 dB bandwidth from the Δ MARKER FREQUENCY display.

(16) Change the TEST INSTRUMENT settings as shown in Table 6-6, and repeat steps (11) through (15) at each setting.

(17) Write the 6 dB bandwidth data in Table 6-5 into Table 6-6.

(18) Calculate the 60 dB and 6 dB bandwidth ratio at each setting. The calculated value must be within the specified value given in Table 6-6.

Table 6-6 Resolution Bandwidth Selectivity

RESOLUTION BW	FREQ SPAN	VIDEO BW	60 dB bandwidth	6 dB bandwidth	Bandwidth selectivity (60dB BW÷6dB BW)	Maximum Selectivity ratio
3MHz	30MHz	1kHz				10:1
1MHz	10MHz	1kHz				10:1
300kHz	3MHz	1kHz				10:1
100kHz	1MHz	1kHz				10:1
30kHz	300kHz	1kHz				7:1
10kHz	100kHz	1kHz				7:1
3kHz	30kHz	100Hz				7:1
1kHz	10kHz	100Hz				7:1
300Hz	3kHz	30Hz				7:1
100Hz	1kHz	30Hz				7:1
30Hz	300Hz	3Hz				7:1
10Hz	100Hz	1Hz				7:1

6.4.6 Residual FM

Residual FM is measured with CAL OUTPUT signal which is a stable 100 MHz signal. The TEST INSTRUMENT is turned in zero span on the slope of the 30 Hz bandwidth response. Then the residual FM is detected over a 0.1 second interval. A peak-to-peak value of a trace is proportional to the residual FM.

6.4.6.1 Specifications

Residual FM: $\leq$ 2 Hzp-p/0.1 sec
at frequency span $\leq$ 10 kHz

6.4.6.2 Setup

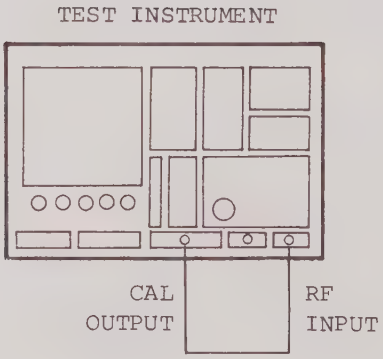


Fig. 6-6 Residual FM Test

6.4.6.3 Procedures

(1) Press FULL SPAN.

(2) Connect CAL OUTPUT to RF INPUT.

(3) Press SHIFT, SWEEP MODE RESTART, and PEAK SEARCH, and adjust AMPTD CAL control so that the marker level is at -10.00 dBm ±0.02 dB.

(4) Press SHIFT, SWEEP TRIGGER LINE, and adjust FREQ ZERO control so that the maximum display value is obtained.

(5) Set REFERENCE LEVEL to -10 dBm. Adjust FREQ ZERO counterclockwise until trace is at the center graticule line.

(6) Set FREQUENCY SPAN to 100 Hz. Press SWEEP SINGLE and RESTART, and wait for completion of the sweep.

(7) Press MARKER NORMAL, and set the marker one division above the center graticule line on the negative-going side of the trace. Press MARKER Δ, and set the active marker one division below the center graticule line.

(8) Compute the slope of the 30 Hz bandwidth response between two markers by dividing the Δ MARKER LEVEL by the Δ MARKER FREQUENCY:

$$\text{slope} = \frac{\Delta \text{ MARKER LEVEL}}{\Delta \text{ MARKER FREQUENCY}} = \_\_\_\_\_ \text{ dB/Hz}$$

(9) Press SWEEP CONTINUOUS.

(10) Set FREQUENCY SPAN to 0 Hz. Readjust FREQ ZERO control, if necessary, to position the trace at the center graticule line.

(11) Set SWEEP TIME to 100 ms.
Press SWEEP SINGLE. The amplitude variations of the trace represent the residual FM.

(12) Press PEAK SEARCH. Press DISPLAY LINE NORMAL and set the display line at the lowest point on the trace.

(13) Press MARKER Δ, and set the active marker at the lowest point on the trace, Read the Δ MARKER LEVEL from the display and record its absolute value.

Δ MARKER LEVEL = p-p value = ____ dB

(14) Divid the p-p value by the slope computed in step (8) to obtain the residual FM.

$$\frac{\text{p-p value}}{\text{slope}} = \text{residual FM}$$

$$\frac{\text{\_\_\_ dB}}{\text{\_\_\_ dB/Hz}} = \text{\_\_\_\_ Hz} = \text{residual FM}$$

(15) Press FULL SPAN.

(16) Press SHIFT, SWEEP TRIGGER LINE, and adjust FREQ ZERO control so that the maximum display value is obtained.

MEMO

6.4.7 Drift

Drift is measured with CAL OUTPUT signal which is a stable 100 MHz signal.

The TEST INSTRUMENT must be warmed up for one hour.

6.4.7.1 Specifications

Drift: $\leq$ 50 Hzp-p/min.
at frequency span $\leq$ 10 kHz
and constant ambient temperature after one hour warm-up.

6.4.7.2 Setup

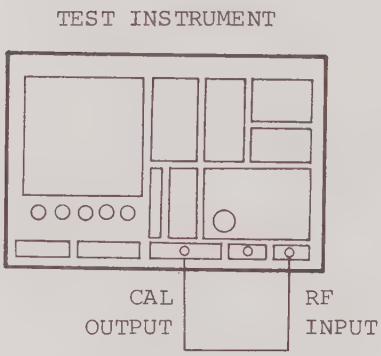


Fig. 6-7 Drift Test

6.4.7.3 Procedures

(1) Press FULL SPAN

(2) Connect CAL OUTPUT to RF INPUT.

(3) Press SHIFT, SWEEP TRIGGER LINE, and adjust FREQ ZERO control so that the maximum display value is obtained.

(4) Set the TEST INSTRUMENT as follows:

FREQUENCY SPAN ..... 10 kHz
SWEEP TIME ..... 60 sec
SWEEP MODE ..... SINGLE

(5) Press DISPLAY Ach CLEAR/WRITE, SWEEP MODE RESTART, and wait for completion of the sweep. Press DISPLAY Ach VIEW after the sweep end.

(6) Press DISPLAY Bch CLEAR/WRITE, SWEEP MODE RESTART, and wait for completion of the sweep. Press DISPLAY Bch VIEW after the sweep end.

(7) Press MARKER NORMAL, DISPLAY Ach VIEW, and PEAK SEARCH. Then, Press MARKER Δ, DISPLAY Bch VIEW, and PEAK SEARCH. Read Δ MARKER FREQUENCY which represents the drift. It should be within ±50 Hz.

(8) Set the TEST INSTRUMENT as follows:

FREQUENCY SPAN ..... 100 Hz
RESOLUTION BW ..... 10 Hz

(9) Press DISPLAY Ach CLEAR/WRITE, SWEEP MODE RESTART, and wait for completion of the sweep. Press DISPLAY Ach VIEW after the sweep end.

(10) Press DISPLAY Bch CLEAR/WRITE, SWEEP MODE RESTART, and wait for completion of the sweep. Press DISPLAY Bch VIEW after the sweep end.

(11) Press MARKER NORMAL, DISPLAY Ach VIEW, and PEAK SEARCH. Then, Press MARKER Δ, DISPLAY Bch VIEW, and PEAK SEARCH. Read Δ MARKER FREQUENCY which represents the drift. It should be within ±50 Hz.

6.4.8 Noise Sidebands

Noise sidebands is measured by a pure signal supplied from a low phase noise signal generator.

6.4.8.1 Specifications

Noise Sidebands: $\leq$ -80 dBc (At 2 kHz away from the signal, resolution bandwidth 100 Hz, video bandwidth 3 Hz, and frequency 1 GHz or less.)

6.4.8.2 Setup

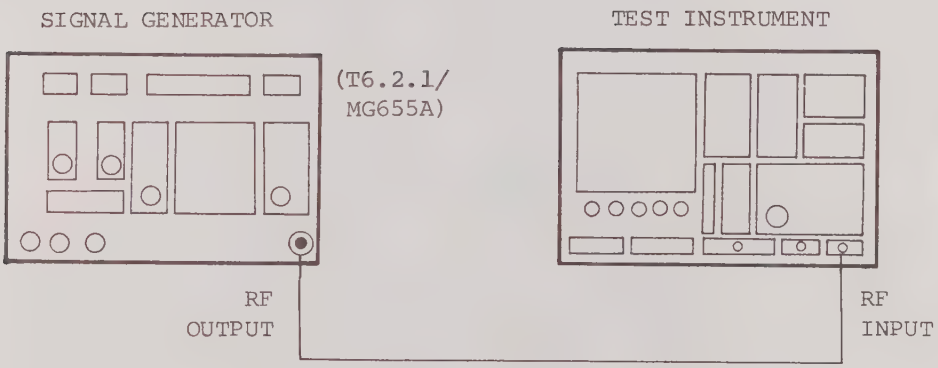


Fig. 6-8 Noise sidebands Test

6.4.8.3 Procedures

(1) Press FULL SPAN.

(2) Connect the output of the signal generator to RF INPUT.

(3) SET the TEST INSTRUMENT as follows:

CENTER FREQUENCY	1 GHz
FREQUENCY SPAN	5 kHz
RESOLUTION BW	100 Hz
INPUT ATTEN	0 dB

(4) SET the signal generator as follows:

Output frequency	1 GHz
Output level	-10 dBm

(5) Wait for completion of sweep, then press PEAK SEARCH and MKR → CF.

(6) Set VIDEO BW to 3 Hz. Press SWEEP MODE SINGLE and RESTART. Wait for completion of sweep.

(7) Press PEAK SEARCH, MARKER Δ, and key-in 2 kHz.

(8) Read Δ MARKER LEVEL. It should be -80 dB or less.

6.4.9 CRT Display Linearity

Display linearity in log and linear modes is tested by decreasing the signal level with a calibrated external attenuator.

The test is devided into three parts. First, the display linearity is tested in LOG scale 10 dB/div, next, in LOG scale 1 dB/div, and finally, in LIN scale.

6.4.9.1 Specifications

LOG: ±0.2 dB/dB, ±1.5 dB/80 dB

LIN: ±3% of reference level (full scale)

6.4.9.2 Setup

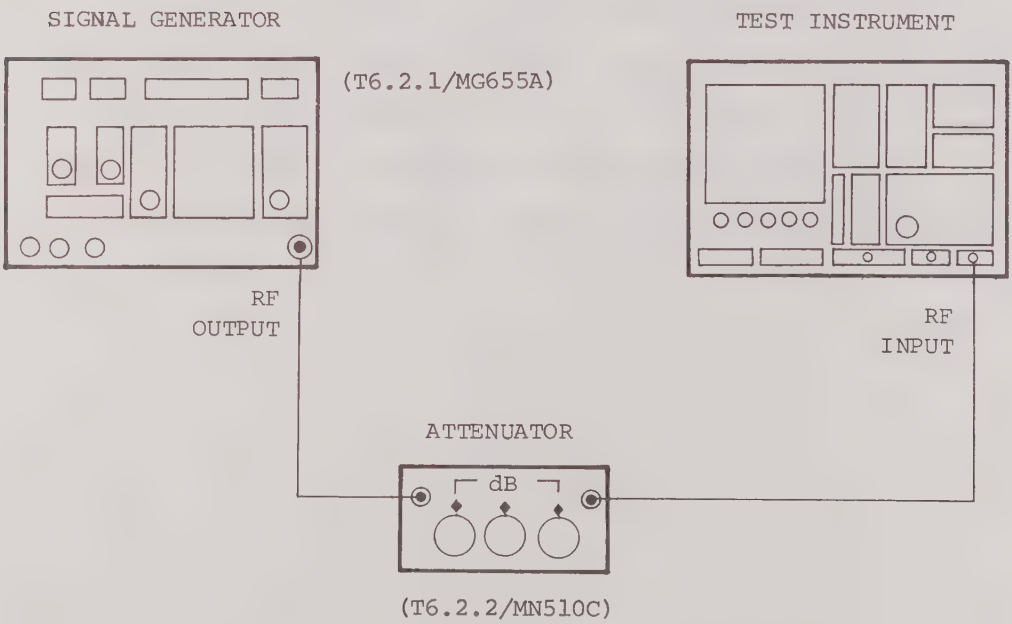


Fig. 6-9 CRT Display Linearity Test

6.4.9.3 Procedures (LOG 10 dB/div)

(1) Set signal generator for an unmodulated 100.000 MHz ±1 kHz output at a level of 0 dBm.

(2) Connect equipment as shown in Fig. 6-9. Set attenuator to 0 dB.

(3) Press FULL SPAN, and set the TEST INSTRUMENT as follows:

CENTER FREQUENCY	100 MHz
FREQUENCY SPAN	10 kHz
REFERENCE LEVEL	0 dBm
INPUT ATTEN	10 dB
RESOLUTION BW	1 kHz

(4) Press PEAK SEARCH and MKR → CF, to center the signal on the display.

(5) Set the TEST INSTRUMENT as follows:

FREQUENCY SPAN	0 Hz
VIDEO BW	100 Hz

(6) Adjust the signal generator output level for a marker level of 0.0 dBm.

(7) Set VIDEO BW to 1 Hz. Press MARKER Δ. Step the attenuator from 0 dB to 80 dB (10 dB step), recording the Δ MARKER LEVEL (a negative value) at each step in column 2 of following Table 6-7. Allow several sweeps after each step for the video filtered trace to reach its final amplitude.

(8) Record the attenuator calibration for each attenuator setting in column 1 of the Table 6-7.

(9) Add the value in column 1 to the value in column 2 for each setting to find the display linearity error.

Table 6-7 LOG Linearity (10 dB/div)

Attenuator setting (dB)	Column 1 Attenuator calibration (dB)	Column 2 ΔMARKER LEVEL (dB)	Linearity error (Column 2 + Column 1) (dB)
0	0 (ref.)	0 (ref.)	0 (ref.)
10			
20			
30			
40			
50			
60			
70			
80			

6.4.9.4 Procedures (LOG 1 dB/div)

(1) Set signal generator for an unmodulated 100.000 MHz ±1 kHz output at a level of 0 dBm.

(2) Connect equipment as shown in Fig. 6-9. Set attenuator to 0 dB.

(3) Press FULL SPAN, and set the TEST INSTRUMENT as follows:

CENTER FREQUENCY ..... 100 MHz
FREQUENCY SPAN ..... 50 kHz
REFERENCE LEVEL ..... 0 dBm
INPUT ATTEN ..... 10 dB
SCALE ..... LOG 1 dB/div
RESOLUTION BW ..... 100 kHz

(4) Press PEAK SEARCH and MKR → CF, to center the signal on the display.

(5) Set the TEST INSTRUMENT as follows:

FREQUENCY SPAN ..... 0 Hz
VIDEO BW ..... 100 Hz

(6) Set the output level of the signal generator according to Table 6-8.
At each setting, execute as follows:

(a) Set the attenuator to 0 dB.

(b) Press MARKER NORMAL.

(c) Adjust the AMPTD CAL so that the MARKER LEVEL is the same as the output level of the signal generator.

(d) Change the attenuator to 1 dB.

(e) Record the Δ MARKER LEVEL (a negative value) in column 1 of Table 6-8.

(7) Add the attenuator calibration to find the corrected linearity error.

Table 6-8 LOG Linearity (1 dB/div)

Output Level of Signal Generator (dBm)	Column 1 MARKER LEVEL (dB)	Column 2 0 → 1 dB Attenuator Calibration	Linearity Error (1+2) (dB)
0	_____	_____dB	_____
-1	_____		_____
-2	_____		_____
-3	_____		_____
-4	_____		_____
-5	_____		_____
-6	_____		_____
-7	_____		_____
-8	_____		_____

6.4.9.5 Procedures (LIN)

(1) Set signal generator for an unmodulated 100.000 MHz ±1 kHz output at a level of 0 dBm.

(2) Connect equipment as shown in Fig. 6-9. Set attenuator to 0 dB.

(3) Press FULL SPAN, and set the TEST INSTRUMENT as follows:

CENTER FREQUENCY	100 MHz
FREQUENCY SPAN	1 MHz
RESOLUTION BW	1 MHz
REFERENCE LEVEL	0 dBm
INPUT ATTEN	10 dB

(4) Press SCALE LIN. Press PEAK SEARCH and MKR → CF, to center the signal on the display.

(5) Set the TEST INSTRUMENT as follows:

FREQUENCY SPAN	0 Hz
VIDEO BW	300 Hz

(6) Adjust the signal generator output level for a marker level of 223.6 mV (0 dBm).

(7) Press MARKER Δ.

(8) Set the attenuator to 10 dB. Record the Δ MARKER LEVEL (X) in column 2 of Table 6-9.

(9) Set the attenuator to 20 dB. Record the Δ MARKER LEVEL (X) in column 2 of following Table 6-9.

(10) Change each value in column 2 of the Table 6-9 to dB unit value, and record its value in column 3. Formula:

Δ MARKER LEVEL (dB) = 20 log [Δ MARKER LEVEL (X)]

(11) Record the attenuator calibrations (errors) corresponding to the 10 dB and 20 dB attenuator settings in column 1 of Table 6-9 (if the 10 dB step is calibrated at 10.1 dB, for example, enter +0.1 dB)

(12) Add the values in column 1 to those in column 2 to find the corrected level differences. The allowable ranges for the level differences are shown in the table.

Table 6-9 LIN Display Linearity

Attenuator Setting (dB)	Column 1 Attenuator Error* (dB)	Column 2 Δ MARKER LEVEL (X)	Column 3 Δ MARKER LEVEL (dB)	Corrected Level Difference (1+3) (dB)	Allowable Range (3% of Ref. Level) (dB)	
					Min.	Max.
10	_____	_____	_____	_____	-10.87	-9.21
20	_____	_____	_____	_____	-23.10	-17.72

* The error is positive if the calibration > the dial setting, negative if the calibration < the dial setting. For example, 9.98 dB calibration for a 10 dB setting represents an error of -0.02 dB.

6.4.10 Calibrator Output Level

The output level of the calibrator signal at the point of the accessory cable is measured with a power meter.

6.4.10.1 Specification

Calibrator output level: -10 dBm ±0.3 dB

6.4.10.2 Setup

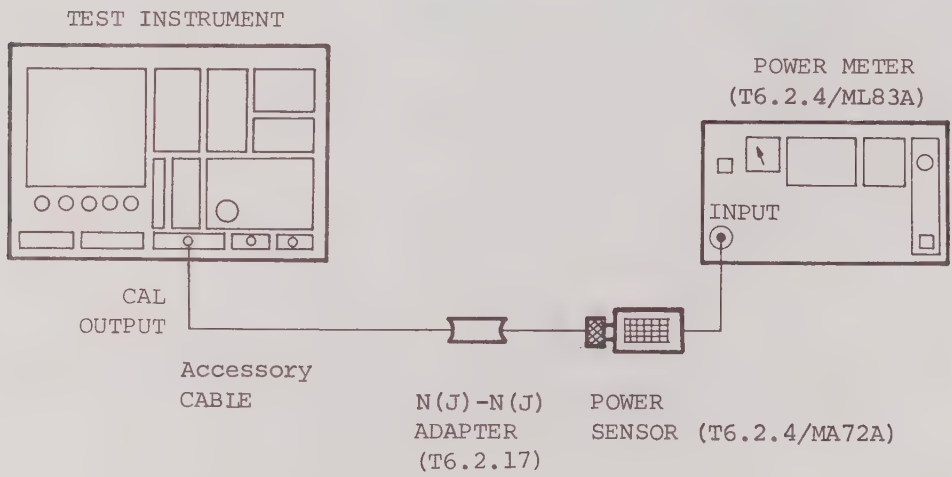


Fig. 6-10 Calibrator Output Level Test

6.4.10.3 Procedures

(1) Connect equipment as shown in Fig. 6-10.

(2) Measure output Level of the CAL OUTPUT signal at the point of the accessory cable.

6.4.11 Frequency Response

Frequency response is tested by slowly sweeping or stepping a accurate level generator over the frequency range and observing the amplitude deviation from the level at 100 MHz.

First, the response is tested from 10 MHz to 2 GHz with a level-controlled sweep oscillator. Next, a synthesizer/level generator is used to measure the response from 50 Hz to 10 MHz.

6.4.11.1 Specifications

Frequency response: ±1.5 dB (50 Hz to 1.5 GHz)

$^{+1.5}_{-3.0}$ dB (1.5 to 2 GHz)

6.4.11.2 Setup (a)

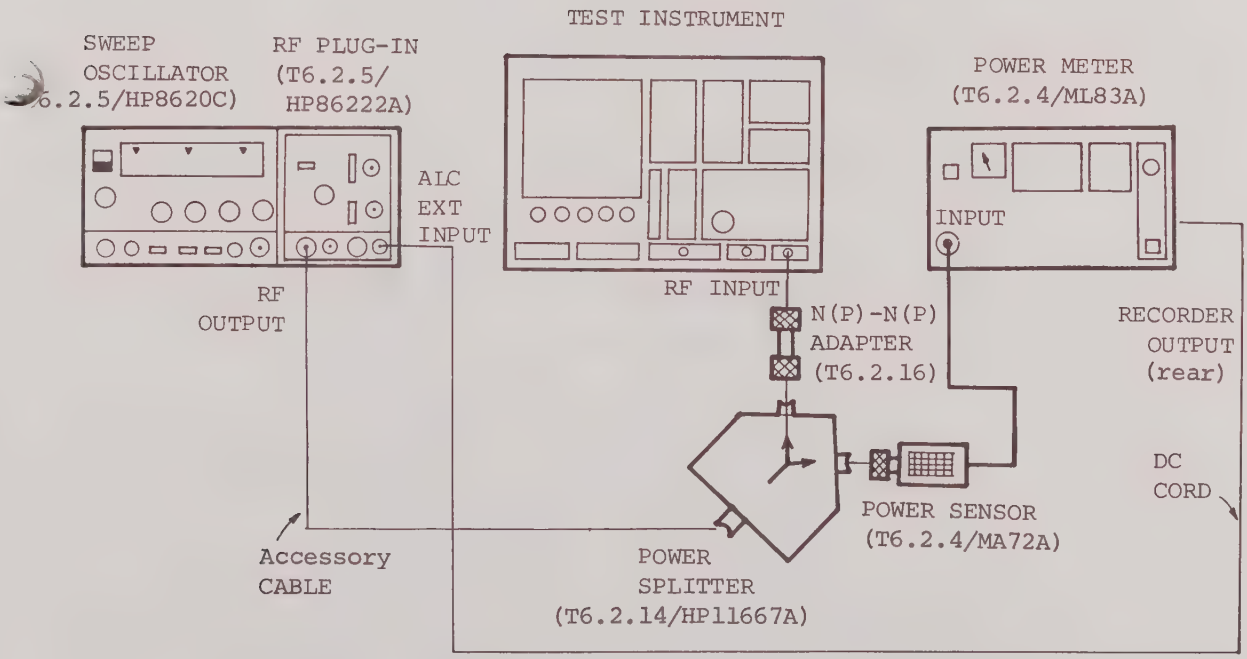


Fig. 6-11 Frequency Response Test (10 MHz to 2 GHz)

6.4.11.2 Setup (b)

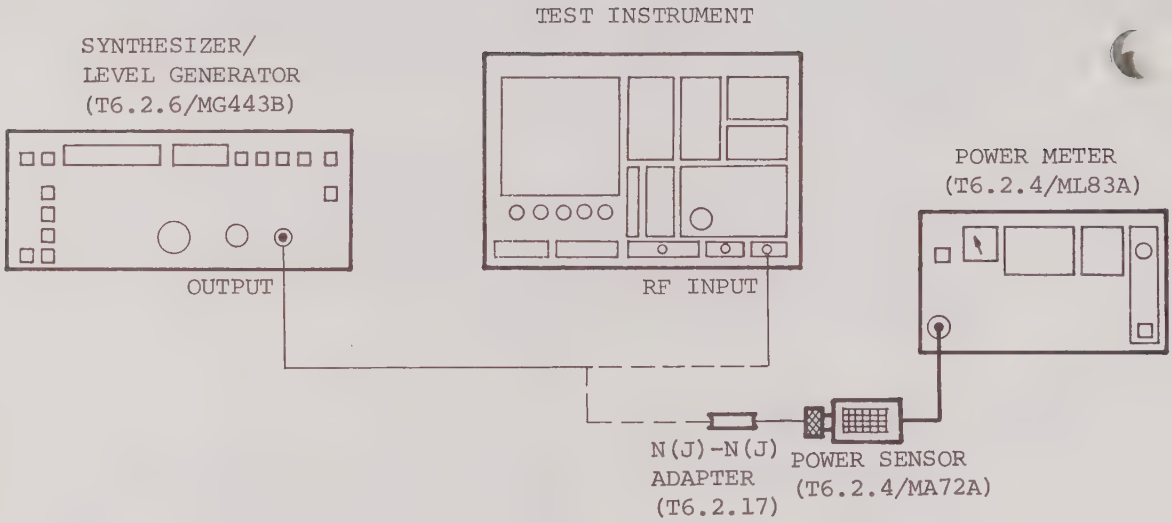


Fig. 6-12 Frequency Response Test
(50 Hz to 10 MHz)

6.4.11.3 Procedures (a)

(1) Set controls as follows:

Power Meter:

Range	0 dBm

Sweep Oscillator:

Start marker	0.01 GHz
Stop marker	2 GHz
CW marker	100 MHz
Sweep mode	AUTO
Sweep trigger	EXT
Sweep time range ..	100 to 10 sec
Time vernier	fully CCW
Markers	OFF

RF Plug-in:

Power level	fully CCW
Mode	OFF
RF off/on	ON
ALC	MTR (meter)
ALC Gain	fully CW
slope	OFF

(2) Press FULL SPAN on the TEST INSTRUMENT.

(3) Connect equipment as shown in Fig. 6-11. The recorder output on rear panel of power meter is connected to external input terminal of ALC of the RF plug-in. One output arm of the power splitter is connected directly (without CABLE) to RF INPUT of the TEST INSTRUMENT via the N(P)-to-N(P) adapter. The power sensor connects directly (without CABLE) to the other splitter output.

(4) Set the TEST INSTRUMENT as follows:

CENTER FREQUENCY	100 MHz
FREQUENCY SPAN	10 MHz
REFERENCE LEVEL	0 dBm
INPUT ATTEN	10 dB (MANUAL)
RESOLUTION BW	1 MHz (MANUAL)

(5) Set the sweep oscillater to CW mode. Adjust CW frequency control to center signal on display.

(6) Adjust power level of the RF plug-in to -2 dBm of the power meter readout.

(7) Set SCALE LOG to 1 dB/div. Adjust AMPTD CAL of the TEST INSTRUMENT to position peak of signal two divisions below the reference level (top) graticule line.

(8) Set the TEST INSTRUMENT as follows:

START FREQUENCY	10 MHz
STOP FREQUENCY	2 GHz

(9) Set the sweep oscillator to sweep mode.

(10) Press DISPLAY Ach CLEAR/WRITE, and MAXHOLD on the TEST INSTRUMENT.

(11) Push sweep oscillater trigger switch to execute single sweep. Wait for completion of sweep. The trace envelop deviation from the graticule line two divisions below that the reference level represents the frequency response from 10 MHz to 2 GHz. The allowable deviation is ±1.5 dB up to 1.5 GHz, and +1.5 dB, -3.0 dB from 1.5 GHz to 2 GHz.

6.4.11.2 Setup (b) ..... Shown again

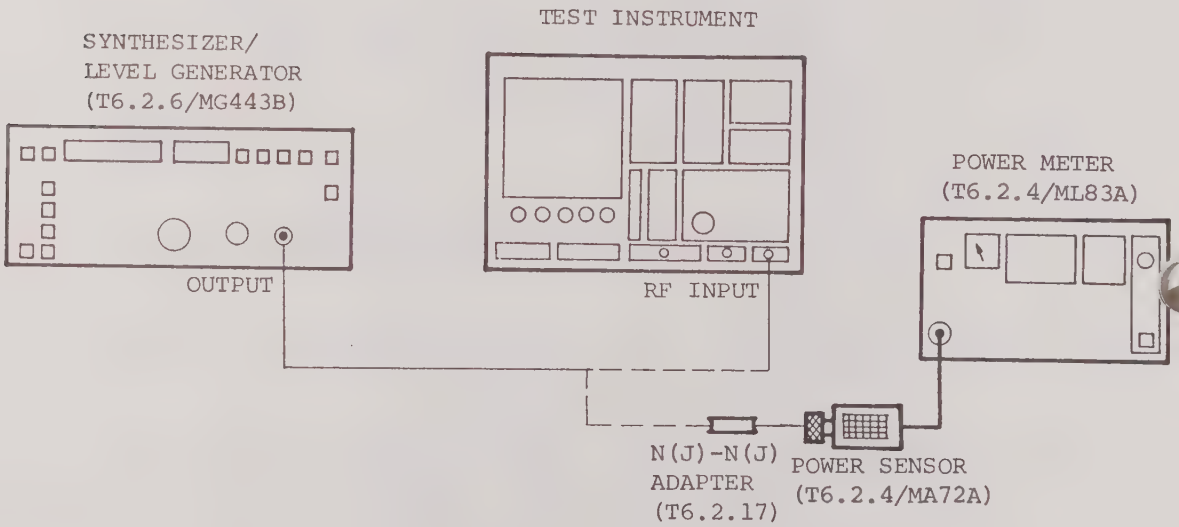


Fig. 6-12 Frequency Response Test
(50 Hz to 10 MHz)

6.4.11.3 Procedures (b)

(12) Change the signal source to synthesizer level generator as shown in Fig. 6-12.

(13) Set the synthesizer as follows:

Center frequency .... 10 MHz
Output level ..... -2 dBm

(14) Connect the output of the synthesizer to the power sensor via N(J)-N(J) adapter, and adjust power level of the synthesizer to -2 dBm for the power meter readout.

(15) Change to connect the output of the synthesizer to the RF INPUT of the TEST INSTRUMENT.

(16) Set the TEST INSTRUMENT as follows:

CENTER FREQUENCY	10 MHz
FREQUENCY SPAN	500 kHz
DISPLAY Ach	CLEAR/WRITE

(17) Press PEAK SEARCH and MARKER Δ.

(18) Change RESOLUTION BW to 30 kHz. Press PEAK SEARCH and adjust the AMPTD CAL control so that the Δ MARKER LEVEL readout is 0.00 dB.

(19) Set the TEST INSTRUMENT as follows:

START FREQUENCY	100 kHz
STOP FREQUENCY	10 MHz

(20) Set the synthesizer as follows:

Start frequency	100 kHz
Stop frequency	10 MHz
Frequency step	10 kHz
Time/step	50 ms

(21) Press DISPLAY Ach CLEAR/WRITE, and MAXHOLD on the TEST INSTRUMENT.

(22) Start single sweep of the synthesizer. Wait for completion of sweep. The trace envelop deviation from the graticule line 2 divisions below that the reference level represents the frequency response from 100 kHz to 10 MHz. The allowable deviation is ±1.5 dB.

(23) Set the frequency of the synthesizer to 10 MHz (CW mode).

(24) Set the TEST INSTRUMENT as follows:

CENTER FREQUENCY	10 MHz
FREQUENCY SPAN	10 kHz
DISPLAY Ach	CLEAR/WRITE

(25) Press MARKER NORMAL, PEAK SEARCH, and MARKER Δ.

(26) Change RESOLUTION BW to 1 kHz. Press PEAK SEARCH and adjust the AMPTD CAL control so that the Δ MARKER LEVEL readout is 0.00 dB.

(27) Change the TEST INSTRUMENT settings as follows:

START FREQUENCY	1 kHz
STOP FREQUENCY	100 kHz

(28) Change the synthesizer settings as follows:

Start frequency	1 kHz
Stop frequency	100 kHz
Frequency step	100 Hz
Time/step	90 ms

(29) Press DISPLAY Ach CLEAR/WRITE, and MAXHOLD on the TEST INSTRUMENT.

(30) Start single sweep of the synthesizer. Wait for completion of sweep. The trace deviation from the graticule line 2 divisions below than the reference level represents the frequency response from 1 kHz to 100 kHz. The allowable deviation is ±1.5 dB.

(31) Set the frequency of the synthesizer to 10 MHz (CW mode).

(32) Set the TEST INSTRUMENT as follows:

CENTER FREQUENCY	10 MHz
FREQUENCY SPAN	1 kHz
DISPLAY Ach	CLEAR/WRITE

(33) Press MARKER NORMAL, PEAK SEARCH and MKR → CF. Change FREQUENCY SPAN to 100 Hz.

(34) Press PEAK SEARCH and MARKER Δ.

(35) Change RESOLUTION BW to 10 Hz. For several sweeps, press PEAK SEARCH and adjust the AMPTD CAL control so that Δ MARKER LEVEL readout is closest to 0.00 dB.

(36) Change the TEST INSTRUMENT settings as follows:

CENTER FREQUENCY	50 Hz
FREQUENCY SPAN	100 Hz
FREQUENCY STEP SIZE ...	100 Hz

(37) Change the frequency of the synthesizer to 50 Hz.

(38) Measure the level of the signal at 50 Hz.

(39) Set the center frequency to 100 Hz. Step the center frequency of the TEST INSTRUMENT from 100 Hz to 1 kHz with STEP key, set the frequency of the synthesizer to match the center frequency of the TEST INSTRUMENT and measure the level of the signal at each step.

(40) The deviation of the signal level at each frequency from -2 dBm represents the frequency response. The allowable deviation is ±1.5 dB.

6.4.12 Reference Level Step Error

Reference level step error consists of IF 10 dB step gain error, IF 1 dB step gain error, IF 0.1 dB step gain error, and input attenuator step error. Maximum of the reference level step error is computed by these errors which are measured separately after executing automatic calibration routine.

6.4.12.1 Specifications

Reference level step error:

after automatic calibration

±0.8 dB (0 to -50 dBm, input attenuator 10 dB)

±1.5 dB (+25 to -100 dBm, input attenuator variable)

6.4.12.2 Setup

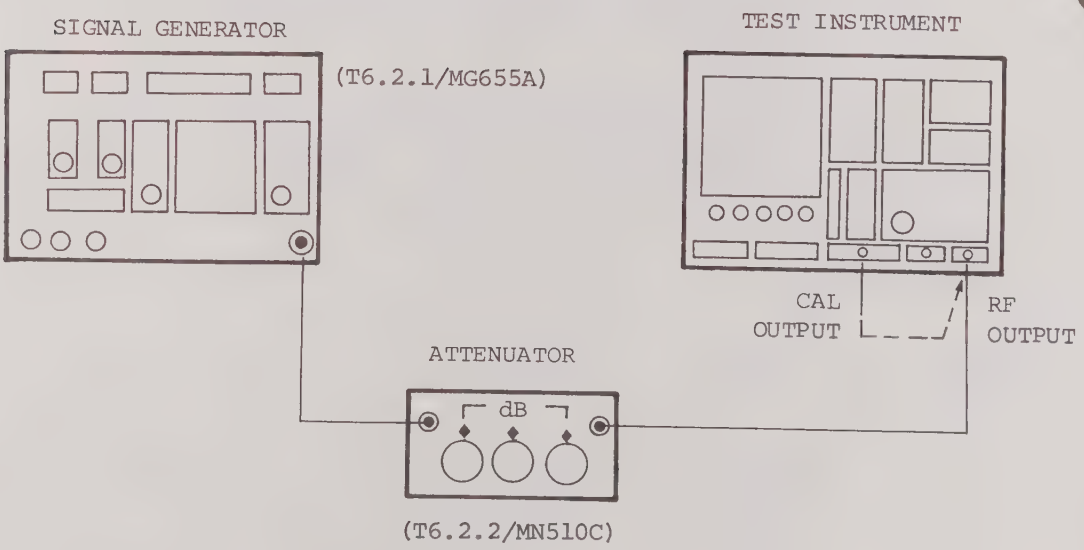


Fig. 6-13 Reference Level Step Error Test

6.4.12.3 Procedures

<AUTO CAL routine>

(1) First, connect the CAL OUTPUT signal to the RF INPUT for automatic calibration.

(2) Press FULL SPAN.

(3) Press SHIFT and SWEEP MODE SINGLE.

(4) Press SHIFT and SWEEP TRIGGER LINE to adjust FREQ ZERO control. Adjust so that the level of the trace displayed on the screen shows the maximum value.

(5) Press SHIFT and SWEEP MODE RESTART to adjust AMPTD CAL control. Press PEAK SEARCH. Adjust the AMPTD CAL control so that the peak level of the trace is -10.00 dBm.

(6) Press SHIFT and FREQ SPAN to execute the AUTO CAL routine. Wait for completion of the routine. When this execution ends, the "AUTO CAL" display on the screen is erased.

<IF 10 dB step at RES, BW 30 kHz>

(7) Set the signal generator for an output frequency of 100 MHz ±0.001 MHz and an output level of -2 dBm.

(8) Connect the output of the signal generator to RF INPUT of the TEST INSTRUMENT through the attenuator as shown in Fig. 6-13, with attenuator set at 0 dB.

(9) Set the TEST INSTRUMENT as follows:

CENTER FREQUENCY	100 MHz
FREQUENCY SPAN	50 kHz
REFERENCE LEVEL	0 dBm
RESOLUTION BW	30 kHz
VIDEO BW	100 Hz
INPUT ATTEN ..	10 dB
SCALE	LOG 1 dB/div

(10) Press PEAK SEARCH, MKR → CF or adjust the center frequency to center signal trace on the display.

(11) Adjust the output level of the signal generator to place peak of trace at the line two divisions below the reference level (top) graticule line.

(12) Press PEAK SEARCH, and MARKER Δ.

(13) Set REFERENCE LEVEL, and the attenuator according to Table 6-10. At each setting, record the Δ MARKER LEVEL in the table. Add the attenuator calibration to find the corrected deviation.

Table 6-10 IF 10 dB Step Gain Error
(at RES. BW 30 kHz)

REFERENCE LEVEL (dBm)	Attenuator Setting (dB)	Column 1 Δ MARKER LEVEL (dB)	Column 2 Attenuator Calibration (dB)	Corrected Deviation (1+2) (dB)
0	0	0 (ref.)	0 (ref.)	0 (ref.)
-10	10	_____	_____	_____
-20	20	_____	_____	_____
-30	30	_____	_____	_____
-40	40	_____	_____	_____
-50	50	_____	_____	_____

<IF 10 dB step at RES.BW 100 kHz>

(14) Set the TEST INSTRUMENT as follows:

FREQUENCY SPAN ... 20 kHz
REFERENCE LEVEL .. 0 dBm
RESOLUTION BW .... 100 kHz
MARKER ..... NORMAL

(15) Change the attenuator setting to 0 dB. Adjust the output level of the signal generator to place peak of trace at the line two divisions below the reference level line.

(16) Press PEAK SEARCH, and MARKER Δ.

(17) Set REFERENCE LEVEL and the attenuator according to Table 6-11. At each setting, record the Δ MARKER LEVEL in the table. Add the attenuator calibration to find the corrected deviation.

Table 6-11 IF 10 dB Step Gain Error (at RES.BW 100 kHz)

REFERENCE LEVEL (dBm)	Attenuator Setting (dB)	Column 1 Δ MARKER LEVEL (dB)	Column 2 Attenuator Calibration (dB)	Corrected Deviation (1+2) dB
0	0	0 (ref.)	0 (ref.)	0 (ref.)
-10	10			
-20	20			
-30	30			
-40	40			
-50	50			

<IF 1 dB step>

(18) Set the TEST INSTRUMENT as follows:

REFERENCE LEVEL ..... 0 dBm
MARKER ..... NORMAL

(19) Press PEAK SEARCH, and MARKER Δ.

(20) Set REFERENCE LEVEL and the attenuator according to Table 6-12. At each setting, record the Δ MARKER LEVEL in the table. Add the attenuator calibration to find the corrected deviation.

Table 6-12 IF 1 dB Step Gain Error

REFERENCE LEVEL (dBm)	Attenuator Setting (dB)	Column 1 Δ MARKER LEVEL (dB)	Column 2 Attenuator Calibration (dB)	Corrected Deviation (1+2)(dB)
0	0	0 (ref.)	0 (ref.)	0 (ref.)
-1	1			
-2	2			
-3	3			
-4	4			
-5	5			
-6	6			
-7	7			
-8	8			
-9	9			

<IF 0.1 dB step>

(18) Set the TEST INSTRUMENT as follows:

REFERENCE LEVEL ... 0 dBm
MARKER ..... NORMAL

(19) Press PEAK SEARCH, and MARKER Δ.

(20) Set REFERENCE LEVEL and the attenuator according to Table 6-13. At each setting, record the Δ MARKER LEVEL in the table. Add the attenuator calibration to find the corrected deviation.

Table 6-13 IF 0.1 dB Step Gain Error

REFERENCE LEVEL (dBm)	Attenuator Setting (dB)	Column 1 Δ MARKER LEVEL (dB)	Column 2 Attenuator Calibration (dB)	Corrected Deviation (1+2)(dB)
0	0	0 (ref.)	0 (ref.)	0 (ref.)
-0.1	0.1			
-0.2	0.2			
-0.3	0.3			
-0.4	0.4			
-0.5	0.5			
-0.6	0.6			
-0.7	0.7			
-0.8	0.8			
-0.9	0.9			

<INPUT ATTEN>

(21) Set the attenuator to 55 dB, and set the signal generator for an output level of +10 dBm.

(22) Set the TEST INSTRUMENT as follows:

REFERENCE LEVEL .... -40 dBm
INPUT ATTEN ..... 0 dB
MARKER ..... NORMAL

(23) Press PEAK SEARCH, and MARKER Δ.

(24) Set REFERENCE LEVEL, INPUT ATTEN and the attenuator according to Table 6-14. At each setting, record the Δ MARKER LEVEL in the table. Subtract the attenuator calibration to find the corrected deviation.

Note: Pressing SHIFT and INPUT ATTEN a function of only changing INPUT ATTEN at a fixed IF gain setting) may be used in order to change the REFERENCE LEVEL automatically coupled to the INPUT ATTEN.

Table 6-14 Input Attenuator Step Error

REFERENCE LEVEL (dBm)	INPUT ATTEN (dB)	Attenuator Setting (dB)	Column 1 MARKER LEVEL (dB)	Column 2 Attenuator Calibration (dB)	Corrected Deviation (1-2) (dB)
-40	0	55			
-35	5	50			
-30	10	45			
-25	15	40			
-20	20	35			
-15	25	30			
-10	30	25			
-5	35	20			
0	40	15			
+5	45	10			
+10	50	5			
+15	55	0			

(25) Find the largest positive corrected deviations and the largest negative corrected deviations in Table 6-11, 6-12, and 6-13, and record these values in following Table 6-15. Compute the total value of above three errors (IF 10 dB step, 1 dB step, and 0.1 dB step) representing the reference level step error at 0 to -50 dBm with input attenuator 10 dB.

(26) Find the largest positive corrected deviation and the largest negative corrected deviation in Table 6-14, and record this values in the Table 6-15. Compute the total value of all representing the reference level step error when the input attenuater variable.

Table 6-15 Reference Level Step Error

Error factor	Largest deviation (dB)		Allowable deviation (dB)
	at RES.BW 30 kHz	at RES.BW 100 kHz	
1. IF 10 dB step (Table 6-11)	+ ____ - ____	+ ____ - ____	
2. IF 1 dB step (Table 6-12)	+ ____ - ____		
3. IF 0.1 dB step (Table 6-13)	+ ____ - ____		
Total of above three (1+2+3)	+ ____ - ____	+ ____ - ____	±0.8
4. INPUT ATTEN (Table 6-14)	+ ____ - ____		
Total of all (1+2+3+4)	+ ____ - ____	+ ____ - ____	±1.5

6.4.13 Resolution Bandwidth Switching Accuracy

Gain error due to switching RESOLUTION BW is measured by using the CAL OUTPUT signal, after executing automatic calibration routine.

6.4.13.1 Specifications

Resolution bandwidth switching accuracy:
±0.4 dB, after automatic calibration.
The 100 kHz bandwidth is used as the reference bandwidth.

6.4.13.2 Setup

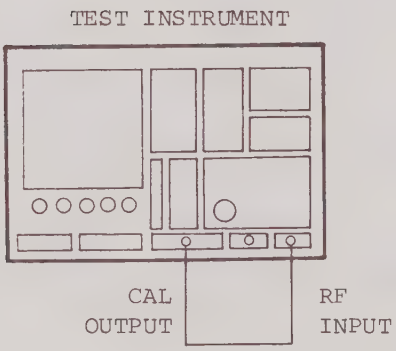


Fig. 6-14 Resolution Bandwidth Switching Accuracy Test

6.4.13.3 Procedures

(1) Press FULL SPAN.

(2) Connect CAL OUTPUT to RF INPUT.

<AUTO CAL routine>

(3) Press SHIFT and SWEEP MODE SINGLE.

(4) Press SHIFT and SWEEP TRIGGER LINE to adjust FREQ ZERO control. Adjust so that the level of the trace displayed on the screen shows the maximum value.

(5) Press SHIFT and SWEEP MODE RESTART to adjust AMPTD CAL control. Press PEAK SEARCH. Adjust the AMPTD CAL so that the peak level of the trace is -10.00 dBm.

(6) Press SHIFT and FREQ SPAN to execute the AUTO CAL routine. Wait for completion of the routine. When this execution ends, the "AUTO CALIBRATION" display on the screen is erased.

<Resolution bandwidth switching>

(7) Set the TEST INSTRUMENT as follows:

REFERENCE LEVEL .... -8 dBm
INPUT ATTEN ..... MANUAL
VIDEO BW ..... 1 kHz

(8) Press PEAK SEARCH, and MARKER Δ.

(9) Set the RESOLUTION BW and FREQUENCY SPAN according to Table 6-16. Press PEAK SEARCH at each setting, then read the Δ MARKER LEVEL.

Table 6-16 Resolution Bandwidth Switching Accuracy

RESOLUTION BW	FREQUENCY SPAN	Δ MARKER LEVEL (dB)
3 MHz	3 MHz	_____
1 MHz	1 MHz	_____
300 kHz	300 kHz	_____
100 kHz	100 kHz	0(ref.)
30 kHz	30 kHz	_____
10 kHz	10 kHz	_____
3 kHz	3 kHz	_____
1 kHz	1 kHz	_____
300 Hz	300 Hz	_____
100 Hz	100 Hz	_____
30 Hz	100 Hz	_____
10 Hz	100 Hz	_____

MEMO

6.4.14 LOG Scale Switching Accuracy

Gain error due to switching LOG scale is measured by using the CAL OUTPUT signal.

6.4.14.1 Specifications

LOG scale switching accuracy: ±0.5 dB

6.4.14.2 Setup

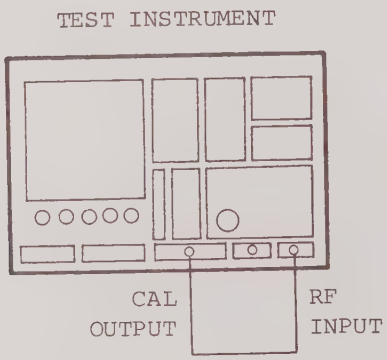


Fig. 6-15 LOG Scale Switching Accuracy Test

6.4.14.3 Procedures

(1) Press FULL SPAN.

(2) Connect CAL OUTPUT to RF INPUT.

(3) Set the TEST INSTRUMENT as follows:

CENTER FREQUENCY	100 MHz
FREQUENCY SPAN	500 kHz
RESOLUTION BW	100 kHz
REFERENCE LEVEL	-8 dBm
SCALE	LOG 1 dB/div

(4) Press PEAK SEARCH, and MARKER Δ.

(5) Step up the LOG scale with STEP up key. At each step, press PEAK SEARCH, then record the Δ MARKER LEVEL in Table 6-17.

(6) Find the peak-to-peak deviation of the Δ MARKER LEVEL values.

Table 6-17 LOG Scale Switching Accuracy

LOG SCALE (dB/div)	Δ MARKER LEVEL (dB)	Peak-to-Peak Deviation (dB)
1	0 (ref.)	
2	_____	
5	_____	_____
10	_____	

6.4.15 Average Noise Level

This test measures the average noise level at 10 Hz resolution bandwidth without any input signal.

6.4.15.1 Specifications

Average noise level:

At input attenuator 0 dB and resolution bandwidth 10 Hz,

-135 dBm maximum (at frequency 0.8 to 2000 MHz)
-100 dBm maximum (at frequency 500 Hz to 800 kHz)
-80 dBm maximum (at frequency 50 Hz to 500 Hz)

6.4.15.2 Setup

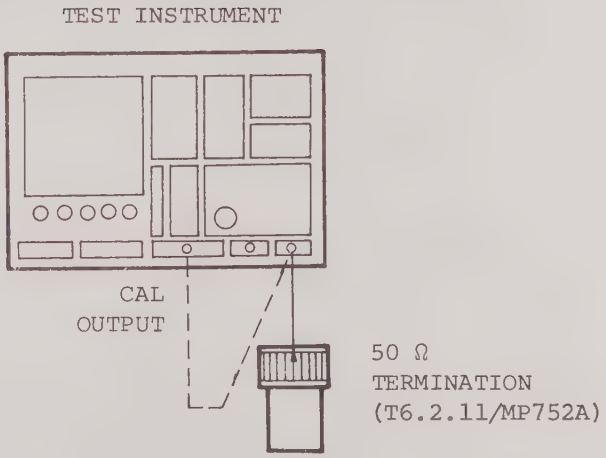


Fig. 6-16 Average Noise Level Test

6.4.15.3 Procedures

(1) Press FULL SPAN.

(2) Connect CAL OUTPUT to RF INPUT.

(3) Press SHIFT, SWEEP MODE RESTART. Press PEAK SEARCH. Adjust the AMPTD CAL so that the peak level of the trace is -10.00 dBm.

(4) Press FULL SPAN.

(5) Disconnect CAL OUTPUT, and terminate RF INPUT with a 50 Ω coaxial termination.

(6) Set the TEST INSTRUMENT as follows:

CENTER FREQUENCY	0.8 MHz
FREQUENCY SPAN	0 Hz
RESOLUTION BW	10 Hz
VIDEO BW	1 Hz
SWEEP TIME	10 sec
SWEEP MODE	SINGLE
REFERENCE LEVEL	-70 dBm
INPUT ATTEN	0 dB

(7) Press SWEEP MODE RESTART and wait for completion of the sweep.

(8) Press DISPLAY LINE NORMAL. Using DATA knob, set the display line to about the center level of the signal trace.

(9) Read the average noise level from the DISPLAY LINE readout. It should be -135 dBm or less.

(10) Change CENTER FREQUENCY to 500 Hz. Follow the procedure of steps (7) through (9). The average noise level should be -100 dBm or less.

(11) Change CENTER FREQUENCY to 50 Hz. Follow the procedure of steps (7) through (9). The average noise level should be -80 dBm or less.

6.4.16 Second Harmonic Distortion

Second harmonic distortion can be measured with a low distortion signal source. The second harmonic level of the signal source must be attenuate 10 dB or more lower the specific value. If the signal generator does not meet this requirement, use a low pass filter.

6.4.16.1 Specifications

Second Harmonic Distortion:

When the value obtained by subracting the attenuation value from the input level is -30 dBm,

-80 dB maximum (at frequency 100 to 900 MHz)

3.4.16.2 Setup

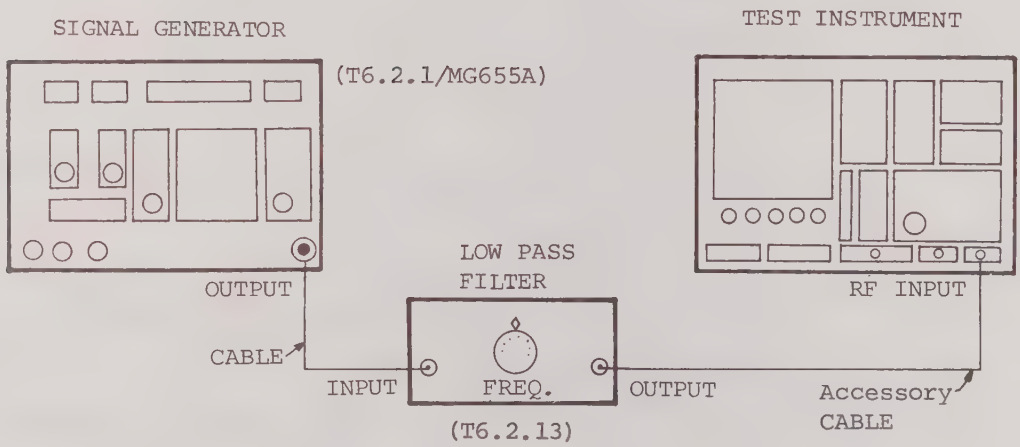


Fig. 6-17 Second Harmonic Distortion Test

6.4.16.3 Procedures

(1) Press FULL SPAN.

(2) Connect the signal generator to RF INPUT through the low pass filter.

(3) Set the signal generator as follows:

Frequency ..... 100 MHz
Output level ... -30 dBm

(4) Set the TEST INSTRUMENT as follows:

CENTER FREQUENCY .... 100 MHz
FREQUENCY SPAN ..... 100 kHz
REFERENCE LEVEL ..... -30 dBm
INPUT ATTEN ..... 0 dB

(5) Adjust the signal generator output level to place the signal peak point at the reference level (top) graticule line.

(6) Press PEAK SEARCH, MKR → CF, MKR/Δ→STEP SIZE, and MARKER Δ.

(7) Press CENTER FREQUENCY and STEP UP key, to display the second harmonic component of the TEST INSTRUMENT.

(8) Press PEAK SEARCH, and read Δ MARKER LEVEL. It should be -80 dB or less.

6.4.17 Two-signal Third Order Intermodulation Distortion

Two-signal third order Intermodulation distortion is measered by applying signals from two separate signal generators to the TEST INSTRUMENT.

6.4.17.1 Specifications

Two-signal Third Order Intermodulation Distortion:

When the value obtained by subtracting the attenuation value from the input level is -25 dBm,

-80 dB maximum (at frequency 20 to 1000 MHz, and frequency difference 2.5 MHz)

-70 dB maximum (at frequency difference 1 kHz to 2.5 MHz)

6.4.17.2 Setup

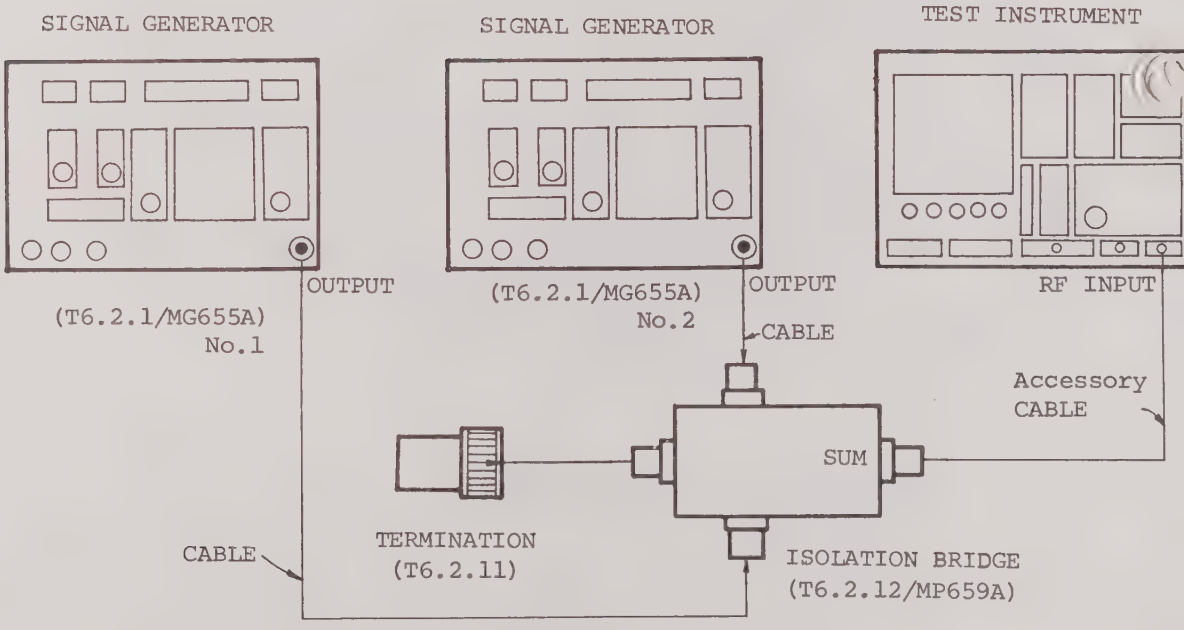


Fig. 6-18 Two-signal Third Order Intermodulation Distortion Test

6.4.17.3 Procedures

(1) Set both signal generators for approximately 100 MHz at a -15 dBm output level.

(2) Connect equipment as shown in Fig. 6-18.

(3) Press FULL SPAN of the TEST INSTRUMENT.

(4) Set the TEST INSTRUMENT as follows:

CENTER FREQUENCY	100 MHz
FREQUENCY SPAN	12.5 MHz
REFERENCE LEVEL	-25 dBm
INPUT ATTEN	0 dB

(5) Tune the signal generators until the signal traces are 2 divisions (2.5 MHz) apart and centered on the display. (Frequency settings are about 98.75 MHz and 101.25 MHz)

(6) Adjust the output levels of both signal generators so that the signal peaks are at the reference level (top) line.

(7) Set the TEST INSTRUMENT as follows:

RESOLUTION BW	1 kHz
VIDEO BW	1 kHz
DISPLAY LINE	-105 dBm

(8) Check for third order intermodulation products at 3 divisions from the center of the display (on both sides). These responses should be below the display line (80 dB or more lower than the input signals).

(9) Set the TEST INSTRUMENT as follows:

FREQUENCY SPAN	5 kHz
RESOLUTION BW	AUTO
VIDEO BW	AUTO

(10) Tune the signal generators until the signal trace are 2 divisions (1 kHz) apart and centered on the display. (Frequency settings are about 99.9995 MHz and 100.0005 MHz)

(11) Set the TEST INSTRUMENT as follows:

RESOLUTION BW ..... 30 Hz
VIDEO BW ..... 10 Hz
DISPLAY LINE ..... -95 dBm

(12) Check for third order intermodulation products at 3 divisions from the center of the display (on both sides). These responses should be lower than the display line (70 dB or more lower than input signals).

MEMO

6.4.18 Residual Response

Residual response is checked across frequency range with no signal applied to the input (with termination) and 0 dB input attenuation.

6.4.18.1 Specifications

Residual Response:

at input attenuator 0 dB and 50 Ω terminated,

-110 dBm maximum (at frequency 1 MHz or higher)
-100 dBm maximum (at frequency 2 kHz to 1 MHz)
-80 dBm maximum (at frequency 50 Hz to 2 kHz)

6.4.18.2 Setup

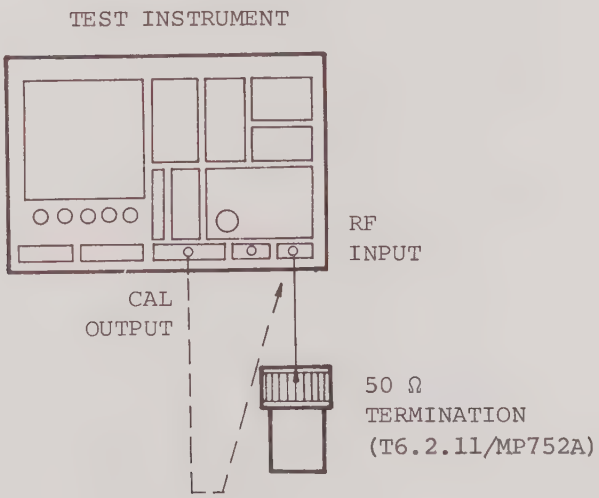


Fig. 6-19 Residual Responce Test

6.4.18.3 Procedures

(1) Press FULL SPAN.

(2) Connect CAL OUTPUT to RF INPUT.

(3) Press SHIFT and SWEEP MODE RESTART. Press PEAK SEARCH. Adjust the AMPTD CAL so that the peak level of the trace is -10.00 dBm.

(4) Press FULL SPAN.

(5) Disconnect CAL OUTPUT, and terminate RF INPUT with a 50 Ω coaxial termination.

(6) Press SHIFT, DISPLAY Ach MAXHOLD (positive peak detection mode).

(7) Set the TEST INSTRUMENT as follows:

REFERENCE LEVEL ...	-50 dBm
INPUT ATTEN	0 dB
SWEEP MODE	SINGLE

(8) Set the TEST INSTRUMENT according to Table 6-18. At each setting, Press SWEEP MODE RESTART and wait for completion of sweep. When the start frequency setting is more than 1 MHz, step up the start frequency with STEP up key, after setting FREQUENCY STEP SIZE to 50 MHz.

(9) Look for any residual responses above the display line. If a residual responce is suspected, press SWEEP MODE RESTART again and see if the residual responce persists.
A residual responce will persists on repeated sweeps, but a noise peak will not.

Table 6-18 Residual Response

START FREQUENCY	STOP FREQUENCY	RESOLUTION BW	VIDEO BW	SWEEP TIME (sec)	DISPLAY LINE (dBm)
50Hz	500Hz	10Hz	3Hz	AUTO (90)	-80
500Hz	2kHz	100Hz	30Hz	AUTO (3)	
2kHz	50kHz	100Hz	100Hz	AUTO (24)	-100
50kHz	1MHz	3kHz	300Hz	AUTO (4.75)	
1MHz 51MHz . . (50MHz STEP) . . 1951MHz	FREQUENCY SPAN 51MHz	3kHz	300Hz	100*	-110

* Though UNCAL lamp lights on at 100 sec of sweep time, the level error is within approx. -0.5 dB.

NOTE:

This test will require approximately 75 minutes to complete for using the settings given in Table 6-18.

(10) IF a response appears marginal, do the following to determine wheather or not it exceeds the specification.

(a) Press SAVE 1.

(b) Press MARKER NORMAL and place the marker on the peak of the response in question.

(c) Press MKR → CF, SWEEP MODE CONTINUOUS, and SWEEP TIME AUTO.

(d) Reduce FREQUENCY SPAN to 1 MHz or less. The level of the response should be below the display line.

(e) Press RECALL 1 to continue the search of redisual responses.

6.4.19 RF INPUT Impedance

Return loss of RF INPUT is measured by SWR autotester.

6.4.19.1 Specifications

RF INPUT Impedance: 50 Ω, VSWR ≤ 1.5
(input attenuator: ≥ 10 dB)

6.4.19.2 Setup

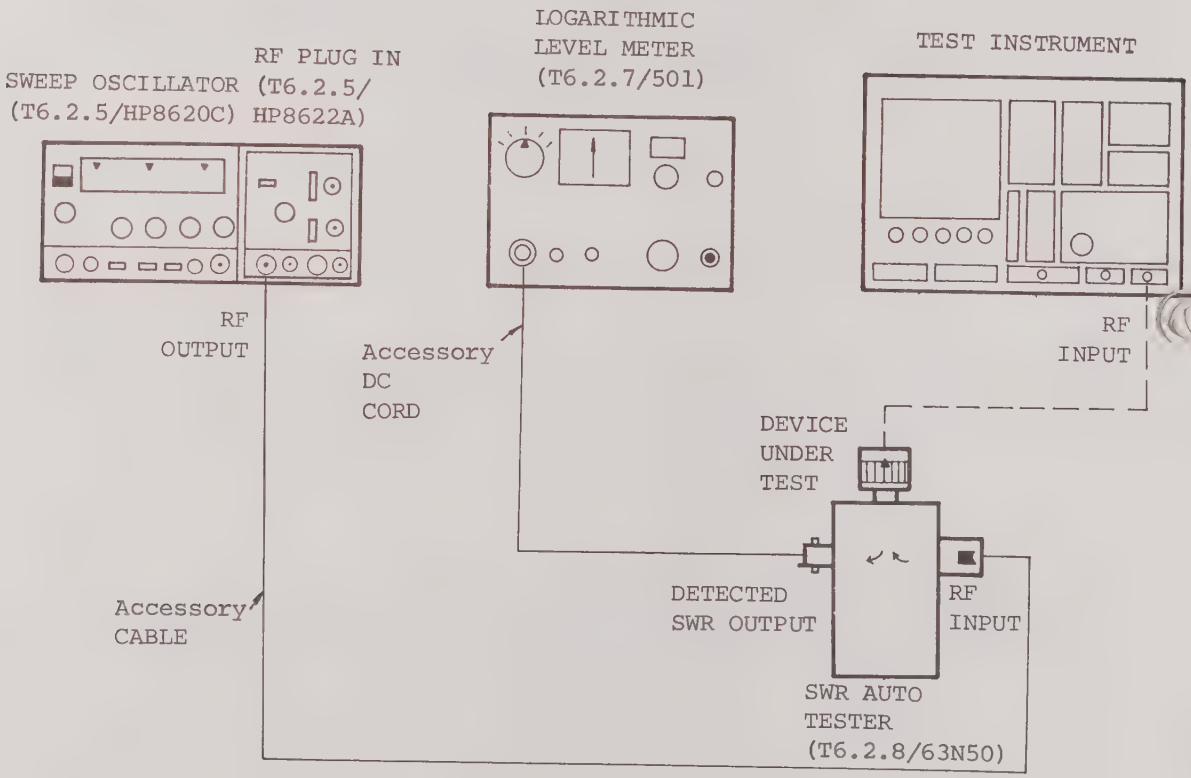


Fig. 6-20 RF INPUT Impedance Test

6.4.19.3 Procedures

(1) Press FULL SPAN.

(2) Connect equipment as shown in Fig. 6-20.

(3) Set sweep oscillator as follows:

CW frequency ... 2 GHz
ALC ..... INT
Power level ... CCW

(4) Set logarithmic level meter as follows:

Sensitivity ... 2 dB/major div
Meter ..... ON

(5) Disconnect the DEVICE UNDER TEST port of SWR autotester from RF INPUT.

(6) Set the offset control of the level meter to 0 dB.

(7) Adjust zero dB set control of the level meter so that the meter indicates 0 dB (center).

(8) Connect the DEVICE UNDER TEST port of SWR autotester directly to the RF INPUT of the TEST INSTRUMENT.

(9) Adjust offset control of the level meter so that the meter indicates 0 dB (center). Read the offset value which means the return loss value.

(10) Change the CW frequency of the sweep oscillator to 1.5 GHz, 1 GHz, and 100 MHz. At each frequency, follow the procedure of steps (5) through (9).

(11) The relation between return loss and VSWR is shown in Table 6-19.

Table 6-19 Relation between return loss and VSWR

Return Loss (dB)	VSWR
10	1.93
11	1.78
12	1.67
13	1.58
14	1.50
15	1.43
16	1.38
17	1.33
18	1.29
19	1.25
20	1.22
25	1.12
30	1.07

Formula:

$$VSWR = \frac{10^{\frac{x}{20}} + 1}{10^{\frac{x}{20}} - 1}$$

where x : return loss (dB)

6.4.20 Power Consumption

Power consumption is measured by measuring the AC voltage and the AC current.

6.4.20.1 Specifications

** V ac ±10%, 50/60 Hz, ≤ 230 VA

6.4.20.2 Setup

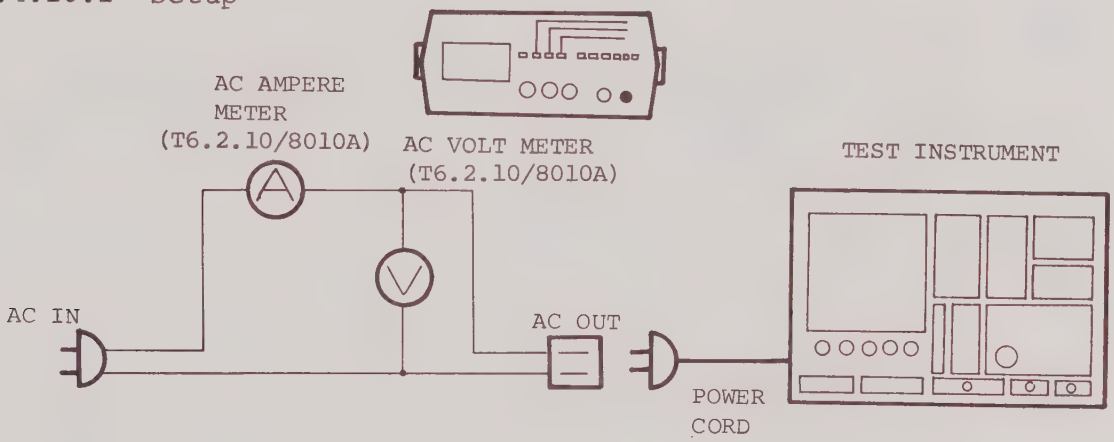


Fig. 6-21 Power Consumption

6.4.20.3 Procedures

(1) Connect the measuring inlet to the commercial voltage supply inlet through the AC AMPERE METER and AC VOLTMETER as shown in Fig. 6-21.

(2) Connect the TEST INSTRUMENT accessory power supply cord to the AC outlet.

(3) Set the TEST INSTRUMENT power switch to ON. Read the value of the AC VOLTMETER and the AC AMPERE METER. The power consumption value is calculated from the following formula:

VA = (reading of the AC VOLTMETER) x
(reading of AC AMPERE METER)

TEST PERFORMANCE SHEET

The test performance sheets were made after careful inspection of your instrument.

Specification items other than the following were also checked and found to be correct.

DATE _____

TEST NO. _____

OPERATOR _____

TEMP. _____

RELATIVE HUMIDITY _____

TESTED BY _____

ITEM 1 CENTER FREQUENCY READOUT ACCURACY

SPECIFICATIONS

±(Tuning frequency x Reference frequency error + 1.5% of frequency span + 50% of resolution bandwidth)

RESULT

MEASUREMENT CONDITION			MEASURED VALUE		
CENTER FREQUENCY	FRFQUENCY SPAN	RESOLUTION BW (AUTO)	Minimum specified value	Marker frequency	Maximum specified value
100MHz	1kHz	30Hz	99.999970MHz	_____	100.000030 MHz
100MHz	10kHz	300Hz	99.99970 MHz	_____	100.00030 MHz
100MHz	100kHz	1kHz	99.9980 MHz	_____	100.0020 MHz
100MHz	1MHz	10kHz	99.980 MHz	_____	100.020 MHz
100MHz	10MHz	30kHz	99.84 MHz	_____	100.16 MHz
100MHz	100MHz	100kHz	98.5 MHz	_____	101.5 MHz
1GHz	1kHz	30Hz	999.999970MHz	_____	1.000000030GHz
1GHz	10kHz	300Hz	999.99970 MHz	_____	1.00000030 GHz
1GHz	100kHz	1kHz	999.9980 MHz	_____	1.0000020 GHz
1GHz	1MHz	10kHz	999.980 MHz	_____	1.000020 GHz
1GHz	10MHz	30kHz	999.84 MHz	_____	1.00016 GHz
1GHz	100MHz	100kHz	998.5 MHz	_____	1.0015 GHz

ITEM 2 FREQUENCY SPAN READOUT ACCURACY

SPECIFICATIONS

±(2.5% of frequency difference between 2 points + 0.5% of frequency span)

RESULT

MEASUREMENT CONDITION				MEASURED VALUE		
		Signal generator setting				
FREQUENCY SPAN	CENTER FREQUENCY	1st measurement setting	2nd measurement setting	Minimum specified value	marker display value	Maximum specified value
1kHz	100MHz	99.9996MHz	100.0004MHz	775 Hz	_____	825 Hz
10kHz	100MHz	99.996 MHz	100.004 MHz	7.75 kHz	_____	8.25 kHz
20kHz	100MHz	99.992 MHz	100.008 MHz	15.50 kHz	_____	16.50 kHz
1MHz	100MHz	99.6 MHz	100.4 MHz	775 kHz	_____	825 kHz
2MHz	100MHz	99.2 MHz	100.8 MHz	1.550MHz	_____	1.650MHz
100MHz	100MHz	60 MHz	140 MHz	77.5 MHz	_____	82.5 MHz
1 GHz	500MHz	100 MHz	900 MHz	775 MHz	_____	825 MHz

ITEM 3 COUNT ACCURACY

SPECIFICATIONS

Readout frequency x Reference frequency error ±2 counts.

Note: The level at the marker position must be 20 dB or more higher than the noise level, or the level of the interference from adjacent signals. Also, the resolution bandwidth must be 5% or more of the frequency span.

RESULT

MEASUREMENT CONDITION	MEASURED VALUE
At peak point	_____
At the slope of response aproximately 20 dB higher than the noise level.	_____
At the peak of the signal which is displayed aproximately 20 dB higher than the noise level.	_____

ITEM 4 REFERENCE OSCILLATOR STABILITY

SPECIFICATIONS

Frequency : 10 MHz

Warm-up characteristics: $\leq 1 \times 10^{-7}$/day after 30 minutes warm-up

$\leq 5 \times 10^{-8}$/day after 60 minutes warm-up

Aging characteristics : $\leq 2 \times 10^{-8}$/day after 24 hours warm-up

Temperature characteristics : $\leq \pm 5 \times 10^{-8}$ at 25°C ±25°C of crystal oscillator ambient temperature

RESULT

ITEM	MEASURED VALUE
Frequency after 30 minutes warm-up (F1)	_____
Frequency after 60 minutes warm-up (F2)	_____
Frequency after 24 hours warm-up (F3)	_____
Frequency after 24 hours and 30 minutws (F1')	_____
Frequency after 25 hours (F2')	_____
Frequency after 48 hours (F3')	_____
Warm-up characteristics per day after 30 minutes warm-up	$\frac{F1 - F1'}{F1'}$ = _____
Warm-up characteristics per day after 60 minutes warm-up	$\frac{F2 - F2'}{F2'}$ = _____
Aging characteristics per day after 24 hours warm-up	$\frac{F3 - F3'}{F3'}$ = _____
Frequency at 0°C (F0)	_____
Frequency at 25°C (F25)	_____
Frequency at 50°C (F50)	_____
Temperature characteristics (25°C - 50°C)	$\frac{F50 - F25}{F25}$ = _____
Temperature characteristics (25°C - 0°C)	$\frac{F0 - F25}{F25}$ = _____

ITEM 5 RESOLUTION BANDWIDTH SELECTIVITY

SPECIFICATIONS

Selectivity (60 dB/6 dB): < 10:1 (3 MHz to 100 kHz)
< 7:1 (30 kHz to 10 kHz)

RESULT

(6 dB bandwidth measurement)

MEASUREMENT CONDITION		MEASURED VALUE
RESOLUTION BW	FREQUENCY SPAN	MARKER Readout of 6 dB Bandwidth
3 MHz	5 MHz	_____
1 MHz	2 MHz	_____
300 kHz	500 kHz	_____
100 kHz	200 kHz	_____
30 kHz	50 kHz	_____
10 kHz	20 kHz	_____
3 kHz	5 kHz	_____
1 kHz	2 kHz	_____
300 Hz	500 Hz	_____
100 Hz	200 Hz	_____
30 Hz	100 Hz	_____
10 Hz	100 Hz	_____

(60 dB bandwidth and selectivity measurement)

MEASUREMENT CONDITION			MEASURED VALUE			
RESOLUTION BW	FREQ. SPAN	VIDEO BW	60 dB bandwidth	6 dB bandwidth	Bandwidth selectivity (60 dB BW ÷ 6 dB BW)	Maximum selectivity ratio
3 MHz	30 MHz	1 kHz	_____	_____	_____	10:1
1 MHz	10 MHz	1 kHz	_____	_____	_____	10:1
300 kHz	3 MHz	1 kHz	_____	_____	_____	10:1
100 kHz	1 MHz	1 kHz	_____	_____	_____	10:1
30 kHz	300 kHz	1 kHz	_____	_____	_____	7:1
10 kHz	100 kHz	1 kHz	_____	_____	_____	7:1
3 kHz	30 kHz	100 Hz	_____	_____	_____	7:1
1 kHz	10 kHz	100 Hz	_____	_____	_____	7:1
300 Hz	3 kHz	30 Hz	_____	_____	_____	7:1
100 Hz	1 kHz	30 Hz	_____	_____	_____	7:1
30 Hz	300 Hz	3 Hz	_____	_____	_____	7:1
10 Hz	100 Hz	1 Hz	_____	_____	_____	7:1

ITEM 6 RESIDUAL FM

SPECIFICATIONS

$\leq$ 2 Hzp-p/0.1 sec
at frequency span $\leq$ 10 kHz

RESULT

ITEM	MEASURED VALUE
The slope of the 30 Hz bandwidth response (A)	$\frac{\Delta \text{ MARKER LEVEL}}{\Delta \text{ MARKER FREQUENCY}}$ = _____ dB/Hz
The trace deviation (B)	Δ MARKER LEVEL (p-p value) = _____ dB
Residual FM: (B : A)	$\frac{B}{A}$ = _____ Hzp-p

ITEM 7 DRIFT

SPECIFICATIONS

≦ 50 Hzp-p/min
at frequency span ≦ 10 kHz, and constant ambient temperature after one hour warm-up

RESULT

MEASUREMENT CONDITION	MEASURED VALUE
Frequency span 10 kHz	_____ Hz
Frequency span 100 Hz	_____ Hz

ITEM 8 NOISE SIDEBANDS

SPECIFICATIONS

≦ -80 dBc
at 2 kHz away from the signal, resolution bandwidth 100 Hz, video bandwidth 3 Hz, and frequency 1 GHz or less

RESULT

ITEM	MEASURED VALUE
Noise sideband	_____ dBc

ITEM 9 CRT DISPLAY LINEARITY

SPECIFICATIONS

LOG: ±0.2 dB/dB
±1.5 dB/80 dB
LIN: ±3% of
reference level (full scale)

RESULT

(LOG Linearith at 10 dB/div)

MEASUREMENT CONDITION	MEASURED VALUE		
	Column 1	Column 2	
Attenuator setting (dB)	Attenuator calibration (dB)	Δ MARKER LEVEL (dB)	Linearity error (Column 2 + Column 1) (dB)
0	0 (ref.)	0 (ref.)	0 (ref.)
10	_____	_____	_____
20	_____	_____	_____
30	_____	_____	_____
40	_____	_____	_____
50	_____	_____	_____
60	_____	_____	_____
70	_____	_____	_____
80	_____	_____	_____

(LOG Linearity at 1 dB/div)

MEASUREMENT CONDITION	MEASURED VALUE		
	Column 1	Column 2	
Output Level of Signal Generator (dBm)	Δ MARKER LEVEL (dB)	0 → 1 dB Attenuator Calibration	Linearity Error (1+2) (dB)
0	_____	_____ dB	_____
-1	_____		_____
-2	_____		_____
-3	_____		_____
-4	_____		_____
-5	_____		_____
-6	_____		_____
-7	_____		_____
-8	_____		_____

(LIN Display Linearity)

MEASUREMENT CONDITION	MEASURED VALUE					
	Column 1	Column 2	Column 3		Allowable Range (±3% of Ref. Level) (dB)	
Attenuator Setting (dB)	Attenuator Error* (dB)	Δ MARKER LEVEL (x)	MARKER LEVEL (dB)	Corrected Level Difference (1+3) (dB)	Min.	Max.
10	_____	_____	_____	_____	-10.87	-9.21
20	_____	_____	_____	_____	-23.10	-17.72

ITEM 10 CALIBRATOR OUTPUT LEVEL

SPECIFICATIONS

-10 dBm ±0.3 dB

RESULT

ITEM	MEASURED VALUE
Calibrator output level	_____ dBm

ITEM 11 FREQUENCY RESPONSE

SPECIFICATIONS

±1.5 dB (50 Hz to 1.5 GHz)

$^{+1.5}_{-3.0}$ dB (1.5 to 2 GHz)

RESULT

MEASUREMENT CONDITION	MEASURED VALUE
10 MHz to 1.5 GHz	+ _____ dB - _____ dB
1.5 to 2 GHz	+ _____ dB - _____ dB
100 kHz to 10 MHz	+ _____ dB - _____ dB
1 kHz to 100 kHz	+ _____ dB - _____ dB

MEASUREMENT CONDITION	MEASURED VALUE	
CENTER FREQUENCY	Column 1 Measurement Level (dBm)	Column 2 Deviation from -2 dBm (1) + 2 dB (dB)
50 Hz	_____	_____
100 Hz	_____	_____
200 Hz	_____	_____
300 Hz	_____	_____
400 Hz	_____	_____
500 Hz	_____	_____
600 Hz	_____	_____
700 Hz	_____	_____
800 Hz	_____	_____
900 Hz	_____	_____
1 kHz	_____	_____

ITEM 12 REFERENCE LEVEL STEP ERROR

SPECIFICATIONS

After automatic calibration
±0.8 dB (0 to -50 dBm,
input attenuator 10 dB)
±1.5 dB (+25 to -100 dBm,
input attenuator variable)

RESULT

(IF 10 dB Step Gain Error at RES.BW: 30 kHz)

MEASUREMENT CONDITION		MEASURED VALUE		
		Column 1	Column 2	
REFERENCE LEVEL (dBm)	Attenuator Setting (dB)	Δ MARKER LEVEL (dB)	Attenuator Calibration (dB)	Corrected Deviation (1+2) (dB)
0	0	0 (ref.)	0 (ref.)	0 (ref.)
-10	10	_____	_____	_____
-20	20	_____	_____	_____
-30	30	_____	_____	_____
-40	40	_____	_____	_____
-50	50	_____	_____	_____

(IF 10 dB Step Gain Error at RES.BW: 100 kHz)

MEASUREMENT CONDITION		MEASURED VALUE		
		Column 1	Column 2	
REFERENCE LEVEL (dBm)	Attenuator Setting (dB)	Δ MARKER LEVEL (dB)	Attenuator Calibration (dB)	Corrected Deviation (1+2) dB
0	0	0 (ref.)	0 (ref.)	0 (ref.)
-10	10	_____	_____	_____
-20	20	_____	_____	_____
-30	30	_____	_____	_____
-40	40	_____	_____	_____
-50	50	_____	_____	_____

(IF 1 dB Step Gain Error)

MEASUREMENT CONDITION		MEASURED VALUE		
		Column 1	Column 2	
REFERENCE LEVEL (dBm)	Attenuator Setting (dB)	Δ MARKER LEVEL (dB)	Attenuator Calibration (dB)	Corrected Deviation (1+2) (dB)
0	0	0 (ref.)	0 (ref.)	0 (ref.)
-1	1			
-2	2			
-3	3			
-4	4			
-5	5			
-6	6			
-7	7			
-8	8			
-9	9			

(IF 0.1 dB Step Gain Error)

MEASUREMENT CONDITION		MEASURED VALUE		
		Column 1	Column 2	
REFERENCE LEVEL (dBm)	Attenuator Setting (dB)	Δ MARKER LEVEL (dB)	Attenuator Calibration dB	Corrected Deviation (1+2) (dB)
0	0	0 (ref.)	0 (ref.)	0 (ref.)
-0.1	0.1			
-0.2	0.2			
-0.3	0.3			
-0.4	0.4			
-0.5	0.5			
-0.6	0.6			
-0.7	0.7			
-0.8	0.8			
-0.9	0.9			

(Input Attenuator Step Error)

MEASUREMENT CONDITION			MEASURED VALUE		
			Column 1	Column 2	
REFERENCE LEVEL (dBm)	INPUT ATTEN (dB)	Attenuator Setting (dB)	Δ MARKER LEVEL (dB)	Attenuator Calibration (dB)	Corrected Deviation (1-2)(dB)
-40	0	55	_____	_____	_____
-35	5	50	_____	_____	_____
-30	10	45	_____	_____	_____
-25	15	40	_____	_____	_____
-20	20	35	_____	_____	_____
-15	25	30	_____	_____	_____
-10	30	25	_____	_____	_____
-5	35	20	_____	_____	_____
0	40	15	_____	_____	_____
+5	45	10	_____	_____	_____
+10	50	5	_____	_____	_____
+15	55	0	_____	_____	_____

(Reference Level Step Error)

Error factor	Largest deviation (dB)		Allowable deviation (dB)
	at RES.BW 30 kHz	at RES.BW 100 kHz	
1. IF 10 dB step	+ ____ - ____	+ ____ - ____	
2. IF 1 dB step	+ ____ - ____		
3. IF 0.1 dB step	+ ____ - ____		
Total of above three (1+2+3)	+ ____ - ____	+ ____ - ____	±0.8
4. INPUT ATTEN	+ ____ - ____		
Total of all (1+2+3+4)	+ ____ - ____	+ ____ - ____	±1.5

ITEM 13 RESOLUTION BANDWIDTH SWITCHING ACCURACY

SPECIFICATIONS

±0.4 dB, after
automatic calibration
(The 100 kHz bandwidth is used as the
reference bandwidth)

RESULT

MEASUREMENT CONDITION		MEASURED VALUE
RESOLUTION BW	FREQUENCY SPAN	Δ MARKER LEVEL (dB)
3MHz	3MHz	_____
1MHz	1MHz	_____
300kHz	300kHz	_____
100kHz	100kHz	0 (ref.)
30kHz	30kHz	_____
10kHz	10kHz	_____
3kHz	3kHz	_____
1kHz	1kHz	_____
300Hz	300Hz	_____
100Hz	100Hz	_____
30Hz	100Hz	_____
10Hz	100Hz	_____

ITEM 14 LOG SCALE SWITCHING ACCURACY

SPECIFICATIONS

±0.5 dB

RESULT

MEASUREMENT CONDITION	MEASURED VALUE	
LOG SCALE (dB/div)	Δ MARKER LEVEL (dB)	Peak-to-Peak Deviation (dB)
1	0 (ref.)	
2	_____	
5	_____	_____
10	_____	

ITEM 15 AVERAGE NOISE LEVEL

SPECIFICATIONS

At input attenuator 0 dB and resolution bandwidth 10 Hz,

≦ -135 dBm (0.8 to 2000 MHz)
≦ -110 dBm (500 Hz to 800 kHz)
≦ -80 dBm (50 Hz to 500 Hz)

RESULT

MEASUREMENT CONDITION	MEASURED VALUE	
CENTER FREQUENCY	Average noise level (dBm)	Maximum specified value (dBm)
0.8 MHz	_____	-135
500 Hz	_____	-110
50 Hz	_____	-80

ITEM 16 SECOND HARMONIC DISTORTION

SPECIFICATIONS

When the value obtained by subtracing the attenuation value from the input level is -30 dBm,

$\leqq$ -80 dB (100 to 900 MHz)

RESULT

MEASUREMENT CONDITION	MEASURED VALUE	
Fundamental frequency	Second harmonic distortion (dB)	Maximum specified value (dB)
100 MHz	_____	-80

ITEM 17 TWO-SIGNAL THIRD ORDER INTERMODULATION DISTORTION

SPECIFICATIONS

When the value obtained by subtracting the attenuation value from the input level is -25 dBm,

≦ -80 dB (at frequency 20 to 1000 MHz and frequency difference 2.5 MHz)

≦ -70 dB (at frequency difference 1 kHz to 2.5 MHz)

RESULT

MEASUREMENT CONDITION		MEASURED VALUE	
CENTER FREQUENCY	Frequency difference	Intermodulation distortion (dB)	Maximam Specified value (dB)
100 MHz	2.5 MHz	_____	-80
100 MHz	1 kHz	_____	-70

ITEM 18 RESIDUAL RESPONSE

SPECIFICATIONS

At input attenuator 0 dB and 50 Ω terminated,

≦ -110 dBm (1 MHz or higher)
≦ -100 dBm (2 kHz to 1 MHz)
≦ -80 dBm (50 Hz to 2 kHz)

RESULT

MEASUREMENT CONDITION					MEASURED VALUE	
START FREQUENCY	STOP FREQUENCY	RESOLUTION BW	VIDEO BW	SWEEP TIME (sec)	Maximum measured response (dBm)	Maximum specified value (dBm)
50Hz	500Hz	10Hz	3Hz	AUTO (90)	_____	-80
500Hz	2kHz	100Hz	30Hz	AUTO (3)	_____	-80
2kHz	50kHz	100Hz	100Hz	AUTO (24)	_____	-100
50kHz	1MHz	3kHz	300Hz	AUTO (4.75)	_____	-100
1MHz 51MHz : (50MHz STEP) : : 1951MHz	FREQUENCY SPAN 51MHz	3kHz	300Hz	100	_____	-110

ITEM 19 RF INPUT IMPEDANCE

SPECIFICATIONS

50 Ω, VSWR $\leqq$ 1.5
(input attenuator
: $\geqq$ 10 dB)

RESULT

MEASUREMENT CONDITION	MEASURED VALUE	
Frequency	Return loss (dB)	VSWR
2 GHz	____	____
1.5 GHz	____	____
1 GHz	____	____
100 MHz	____	____

ITEM 20 POWER CONSUMPTION

SPECIFICATIONS

** Vac ±10%, 50/60 Hz, ≤ 230 VA

RESULT

ITEM	MEASURED VALUE
AC voltmeter readout (V)	_____ V
AC ammeter readout (A)	_____ A
Power consumption (V x A)	_____ VA

SECTION 7

STORAGE

7.1 Notes on Storage

The following should be noted when storing the MS611A for long periods of time.

(1) The device should be cleaned prior to storage.

(2) Do not store the device in places subject to extreme temperatures (below -25°C or over 55°C) and humidity (over 90%).

(3) Do not store the device in places subject to direct sunlight.

(4) Do not store the device in dusty, dirty places.

(5) Do not store the device in places exposed to active gases or places where condensation easily occurs as this will cause corrosion.

7.2 Recommended Storage Conditions

In addition to satisfying the requirements in Paragraph 7.1, the following conditions are recommended when storing the device for long periods of time. Temperature: 0 to 30°C; Humidity: 40 to 80% (places where temperature and humidity do not fluctuate appreciably).

MP MASTER
MA33392